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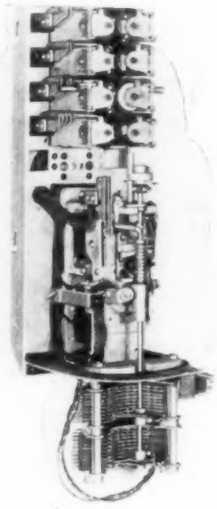

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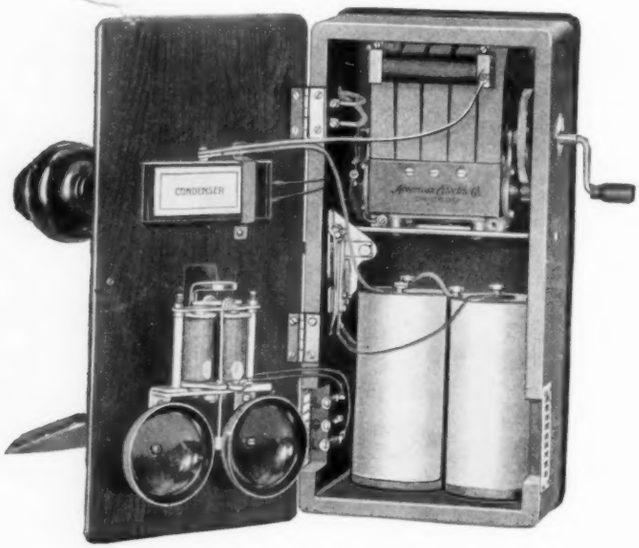

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Subscriber Loop Problems

Proper Design of the Subscriber Loop is an Important Matter in Transmission Efficiency—Factors which Establish Allowable Length of Circuit are Discussed in This Paper

By R. V. Achatz

Quality of transmission is one of the most important factors in the rendering of satisfactory telephone service. For this reason, the companies operating long distance lines have made exhaustive studies of the subject and have developed highly trained staffs of specialists whose duty it is to design the plant properly and to maintain it so that it will provide transmission of a grade that will permit easy conversation between ordinary users. Standards of transmission have been fixed and expensive plants have been constructed to meet the standards.

Unfortunately, it can not be said that the same care has been taken in the design of the local exchange plant in many cases. In fact many exchanges and some of them of considerable size, have been designed and constructed without any consideration whatever of the quality of transmission to be provided. This condition is due partly to the fact that the importance of the matter has not been appreciated and partly to the fact that information of a usable character has not been available.

As long as exchange plants were principally of open wire construction and local battery service was in use in exchanges of considerable size, this problem of exchange transmission was not so serious. However, as cable and twisted pair distribution has been extended to cover areas remote from the central office and as there is a growing tendency to extend cable even beyond exchange limits to replace open wire on some of the heavier loaded rural lines, it is becoming of more and more importance. There is also a tendency to convert farm lines working into common battery exchanges to common battery transmission with selective ringing and this also introduces the question of allowable transmission losses.

It is with the idea of presenting some of the facts in connection with the problem of transmission in the subscribers loop that this article is presented although there is little new material on the subject contained in it.

Permissible Losses Depend Upon Conditions

Nearly every telephone man is familiar with the method of measuring transmission losses by comparison with the standard 19 gauge cable. Transmission through about 30 miles of this cable with a specified type of common battery substation set at each end is considered to be the limit for satisfactory commercial service. In practice it may be desirable to design the plant so that the equivalent will be somewhat less than this to provide a margin of safety. For the ordinary exchange plant, an equivalent of 18 to 25 miles of standard cable is adopted for transmission between two subscribers in the same exchange area. The equivalent adopted will depend upon whether the exchange is single or multi-office and upon other factors.

Transmission within the local exchange area is not the only factor to be considered however, as there is a possibility that any exchange line may be connected to the long distance lines and the transmission equivalent of the local line when connected for a long distance call must also be kept within limits that will permit satisfactory conversation over the long distance connection. The long distance companies have certain standards for transmission between toll centers and the permissible equivalents of the local lines are fixed from a consideration of the general toll line layout. Long distance companies will usually furnish the information as to the permissible equivalent for exchanges connected to their lines. About 12 miles of standard cable represents a safe value in most cases.

Two Sources of Loss in Subscribers Lines

There are two types of transmission losses that may occur in a connection between two subscribers or between a subscriber and a long distance line. One of these types is the high frequency loss which occurs in each portion of the line and in every piece of apparatus connected to the circuit. The other is the current supply loss which occurs only in the line of the subscriber when he is transmitting.

It is a matter of common knowledge that a reduction in the current supplied to a transmitter will cause a reduction in the volume of outgoing transmission from that station. On account of reduction in current supply due to the resistance of the line, the transmission from a subscriber located in an outlying district of the exchange is poorer than from a subscriber located near the central office aside from any losses caused by the additional line itself. These losses may be expressed in terms of standard cable equivalents just as may any other losses and are known as current supply losses.

Current Supply Losses May be Large

An idea of the transmission loss produced by a reduction in the current supplied to the transmitter may be obtained from Fig. 1. The curve marked A is given as the loss for the type of transmitter specified for use with the testing circuit, the Western Electric, No. 229. Curves B, C and D are taken from tests of other types of transmitters. The three latter curves although drawn on the same figures are not to be understood as giving a comparison between types of transmitters as the tests from which the curves were determined were not made under the same conditions nor was quality of transmission as deter-

mined by articulation tests considered. They do show, however, that with any type of transmitter, substantial losses occur when the current is reduced. Thus, if the current is reduced to 50 milliamperes, losses equivalent to five to ten miles of standard cable will be sustained while if the current is reduced to 25 milliamperes the losses will be from 10 to 15 miles due to this cause alone.

High Frequency Losses Depend Upon Type of Line

The high frequency losses in any type of line depend upon the four primary constants of the line, resistance, capacity, inductance and leakage. In loaded lines another type of loss called reflection loss occurs but loaded cable is not used in subscriber loops except possibly in special cases in very large multi-office exchanges. The transmission equivalents of various types of line have been worked out and have been published in a number of places. Some of the values of the equivalents of types of line used in subscriber loops are given in Table 1.

Total Losses in Local Connection

The relative effect of the various factors which cause reduction in volume of transmission in a connection between local exchange subscribers in a single office exchange for a certain set of assumed conditions is shown in Fig. 2. The following conditions were assumed in computing the losses: (1) The high frequency loss in the central office from main frame terminal to main frame terminal is one and one-half miles of standard cable. (2) The battery voltage is 24 volts and the resistance in the current supply circuit within the central office is 120 ohms. In actual practice in modern 24 volt central office equipment the resistance may be as low as about 60 ohms or as high as about 230 ohms. (3) The subscriber lines consist of No. 22 B & S Ga. .07 mf. cable having a resistance of 176 ohms per loop mile with drop and inside wire short enough to be negligible. (4) The resistance of the subscriber set is taken as 40 ohms and it is assumed to have equal transmitting and receiving efficiency as the set specified for the testing circuit.

It will be noted from Fig. 2 that the total equivalent of the connection between two subscribers, each having a loop of three miles of cable, is 20 miles. Nearly one half of this equivalent or 9½ miles is due to current supply loss. For loops shorter than about 2½ miles, over one half of the equivalent is due to current supply loss in the transmitting loop. This of course occurs in one loop only unless the direct current or electromagnetic type of receiver is used, in which case an additional loss is likely to occur when the current is small.

Some idea of the effect of resistance in the central office may be obtained from values that were computed but not shown in the drawings. The total equivalent of a connection between two three-mile loops of No. 22 Ga. cable with a central office circuit of 60 ohms would be one-half mile less than that given in Fig. 2 and for 230 ohms in the central office would be .8 miles greater.

Losses in Toll Connections.

Fig 3 shows the loss in one exchange on a long distance connection. This loss is given for the station that

TABLE I.

Transmission Equivalents of Various Types of Line

Type of Line	Resistance per Loop Miles	Transmission Equivalent
Cable		
No. 22 B&S ga. .070 mf. mutual capacity	176	1.53
No. 22 B&S ga. .083 mf. mutual capacity	176	1.66
No. 19 B&S ga. .074 mf. mutual capacity	88	1.11
Open Wire		
No. 12 B&S ga. copper	17.4	.122
No. 12 BWG iron	72	.32
No. 14 BWG iron	125	.40
Twisted Pair		
No. 14 B&S ga. copper	27	.80
No. 17 B&S ga. copper-steel	190	1.70

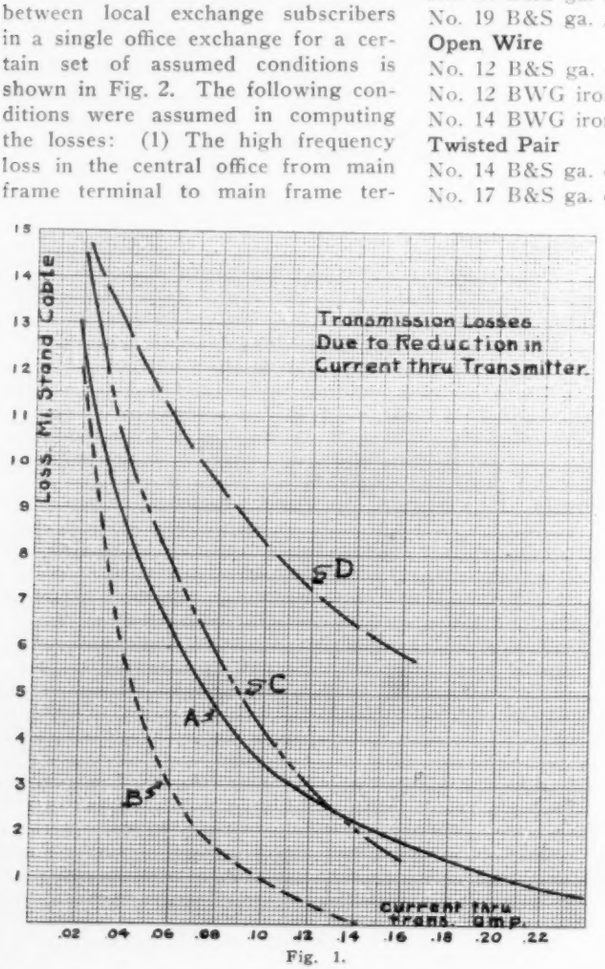

Loss Mi. Stand Cable
Transmission Losses Due to Reduction in Current thru Transmitter.
D
C
A
B
Current thru Trans. Amp.
.02 .04 .06 .08 .10 .12 .14 .16 .18 .20 .22

Fig. 1.

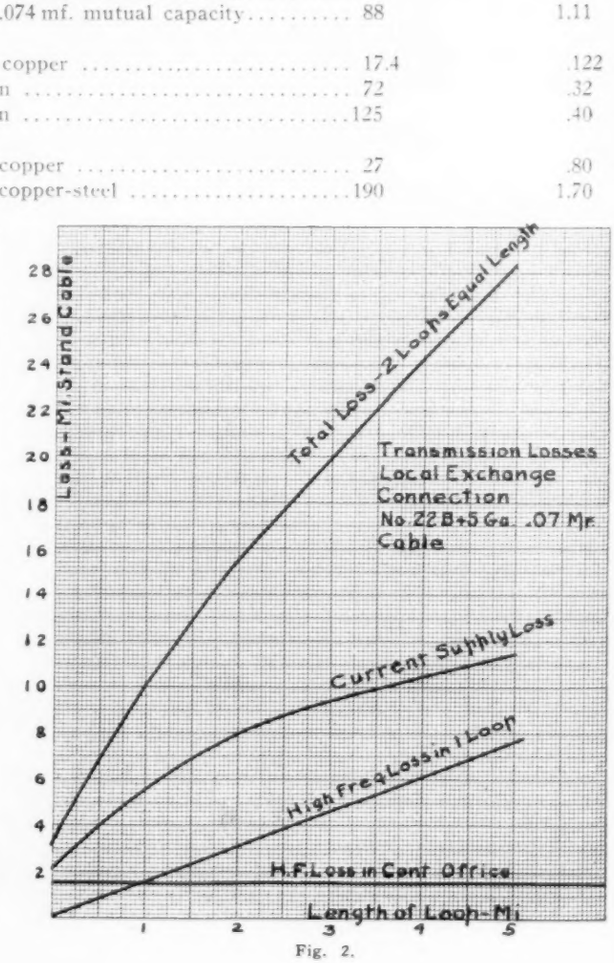

Loss-Mi. Stand Cable
Total Loss-2 Loops Equal Length
Transmission Losses Local Exchange Connection No 22 B+S Ga .07 Mf Cable
Current Supply Loss
High Freq Loss in 1 Loop
H.F. Loss in Cent. Office
Length of Loop-Mi
1 2 3 4 5

Fig. 2.

is doing the talking as the current supply loss would not occur in the receiving loop. The values given here are for the same conditions as given in the preceding figure except that the high frequency loss in the central office is taken as one mile to represent the equivalent of the switching trunk and wiring and the current is assumed to be supplied at a pressure of 48 volts. It will be noted here that the current supply loss is again the largest single factor.

It is evident from the consideration of Figs. 2 and 3 that the limiting length of subscribers loop in a single office exchange is determined by the necessity for good transmission on toll connections rather than on local connections. For instance, under the conditions assumed, a subscriber loop of 4 miles of No. 22 Ga. cable would give a 24 mile equivalent on a local connection with a similar loop. This would probably be considered a satisfactory transmission. On a toll connection even with 48 volt battery, the equivalent of the outgoing loop alone would be nearly 14 miles. Adding to this the equivalent of the loop in the distant office would exceed the allowable limit. A transmitting loop of 2 miles would have an equivalent of 8 miles and allowing for a receiving loop of equal length in the distant office with an equivalent of 4 miles, the total equivalent would be 12 miles. From these considerations it would seem that about 2 miles or in extreme cases 2½ miles of No. 22 Ga. .07 mf. capacity cable would be as much as would be possible to include in a subscriber loop and still have satisfactory transmission. Similar studies might be made to determine permissible strengths of other winds of line or combination of two or more kinds.

Transmission on Common Battery Farm Lines

As a matter of interest the transmission equivalents of common battery farm lines were computed on the same basis as local exchange lines. It was assumed that the lines included one mile of No. 22 B&S. Ga. .07 mf. cable and varying length of No. 12 BWG iron metallic circuit. The computations were based on new line. For a line 10 miles long, the total equivalent was computed as 22 miles assuming two equal loops as would be the case if two neighbors on different lines were connected. This circuit would be unsatisfactory for toll service however, as the equivalent of the transmitting loop would be about 13.7 miles. Probably about 6 miles of No. 12 iron circuit would be the maximum length that could be used with 1 mi. of No. 22 ga. cable for satisfactory transmission.

If the length of the cable were increased to 2 miles the limit would be reached at the end of the cable without any open wire line. This illustrates the difficulty that may arise when an attempt is made to combine common battery transmission on farm lines with long lengths of cable to relieve heavily loaded open wire lines. The alternatives seem to be to retain the local battery transmission or to keep down the length of cable.

Delinquent Gets "Hard-Boiled"—Commission Calls Him

Butler, Pa.—A decision favorable to the Peoples Telephone Co. of Butler, has been made by the Public Service Commission in a case growing out of a delinquent subscriber's demand for restoration of service without payment of the penalty for remittances not received within a given time limit, prescribed in the company's rates. The subscriber's testimony that payment was entrusted to the mails at a date early enough to bring it under the deadline was not in accord with the facts set forth by local postal authorities. The commission held that discontinuance of service was justified, and dismissed the complaintant's plea for restoration of service without payment of penalty.

Radio Sets for Bed-Ridden Is Paul Shuey's Hobby

Fort Dodge, Iowa.—The Monarch Message, the interesting house organ of the Monarch Telephone Mfg. Co., tells of the work of Paul Shuey, formerly associated with Kansas and Purdue universities and now with the Mellon Institute, in equipping seventy beds in the Pittsburgh Tuberculosis Hospital with radio sets. All of the work has been done at Mr. Shuey's expense. He is starting a movement to equip every hospital in the country with radio service.

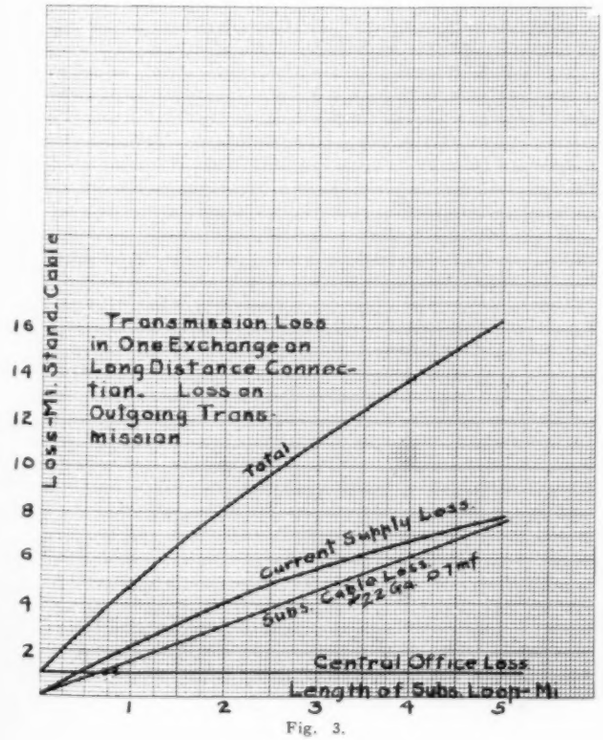


Fig. 3.

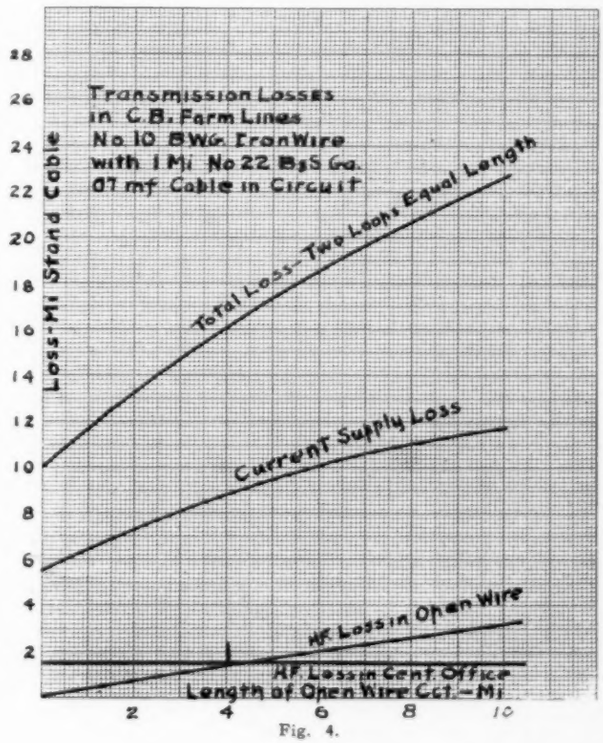


Fig. 4.

Transmission Maintenance

Money Value of Mile of Standard Cable Impressive Reminder of Good Transmission's Importance—Some Factors and Methods in Making the Correct Tests

By E. B. King

Before Purdue Telephone Plant School

"In the telephone system connecting lines and trunks are first needed, and to these are added certain terminal apparatus and the sub-sets; but this is not the product we have up for sale to the public for it is transmission that they demand. Good transmission can no longer be considered a luxury; it is an essential to the telephone plant. The three important requirements for satisfactory transmission are: (1) Sufficient energy or volume at the called subscriber's station; (2) good quality, and (3) minimum of interference.

"They say that in the old days a man was trying to talk from the Battery in New York to the upper part of Manhattan, a distance of about twelve miles, and the man at the other end could not hear him. The operator asked him several times if he could speak louder, to which he finally replied, 'If I could, I wouldn't have to use this telephone.'

"Coming up to the present time, however, a striking contrast to this is illustrated by a recent conversation which was overheard by someone monitoring on the New York-San Francisco line. A man at San Francisco was saying, "Why, Jim, this is a bang-up good talk. I am going to call you again tomorrow, and if we can talk as well as this, I will call you right along."

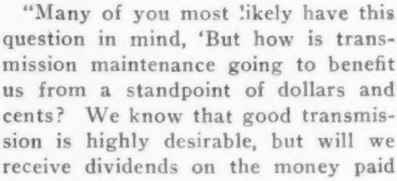
"So we see that there are other advantages of good transmission besides patrons, for it means a larger business and increased profits to the telephone companies. Also with a standard grade of transmission, there would be very few cases of repetition of numbers or of the caller getting the wrong party; and in this way a large saving could be effected, as fewer operators and a decreased number of trunks would be sufficient.

Improved Transmission Means Saving

"Savings due to clearing up transmission troubles are not paper savings; they are not stage money. Like other maintenance work, transmission maintenance, which merely means 'keeping what we have,' looks primarily toward future, rather than immediate savings. In this respect it may be compared to pole inspection and replacement work; except that excessive transmission losses in the plant are not only a source of danger, leading to a complete breakdown of service in the future, but also constitute a continued impairment of service until remedied.

"Many of you most likely have this question in mind, 'But how is transmission maintenance going to benefit us from a standpoint of dollars and cents? We know that good transmission is highly desirable, but will we receive dividends on the money paid out for it.'

"Before answering these questions, let us first determine what is meant by transmission loss, and how it is measured. As most of you probably know, transmission loss is an energy loss; it is the attenuation of the voice currents in passing from one part of the telephone circuit to another. This loss is measured in terms of standard No. 19 gauge cable with a resistance of eighty-eight ohms per loop mile and a capacity between wire of .054 microfarads per mile. This is the 'yard stick' of transmission and by getting our cables, open wire, and equipment in terms of this 'yard stick' we can tell just what loss we should get over our circuits. The transmission equivalent of a toll circuit, for in-



stance, is the number of miles of standard No. 19 gauge cable that would give the same loss as the existing cable or open wire. One mile of No. 22 gauge cable has an equivalent of one and seven-tenths miles, while one mile of No. 12 N. B. S. gauge copper wire has an equivalent of seventy-nine thousandths miles. This means that if a party were talking at the end A, that he would be heard equally well at the points B and C. So by comparison to the transmission 'yard stick' we see that it takes twenty-one and five-tenths miles $\frac{1.7}{.079}$ of No. 12 N. B. S. gauge copper wire to give the same transmission loss as one mile of No. 22 gauge cable. Likewise all gauges of cable and open wire, as well as all pieces of telephone equipment, have their individual transmission equivalents which have been determined by experiment.

"Now, how are we to apply this to our plant in actual practice? From past experience and present practices, the standard of transmission from the calling to called party has been set at about twenty-one miles for local connections and twenty-six miles for toll connections. These figures are not geographic miles, but transmission miles as explained previously. By use of the transmission equivalents, a fundamental plan is first made to determine the size of wire, kind of equipment, etc., that it is necessary to install, to keep within the limits of transmission. When the circuits are put into service all will then meet the transmission requirements, if everything has been installed correctly. But how are we to determine that all installations have been correct, and can we expect the local circuits to give always a maximum of twenty-one miles equivalent? Instead, without transmission maintenance, many of the circuits will have an equivalent of twenty-five miles, thirty miles or even higher.

Money Value of a Mile of Standard Cable

"Why spend the money to put in circuits of standard requirements, unless we intend to maintain them up to that standard; for each extra mile of transmission costs on the average of about fifteen cents per station per year. If the plant is not maintained the average transmission loss may be as high as twenty-five miles, which is four miles excess. Had the plant been designed originally for this

twenty-five mile instead of a twenty-one mile equivalent, a saving of sixty cents per station per year would have been affected, which for the 450,000 stations in Indiana, would amount to a yearly saving of $270,000. On the other hand the cost of transmission maintenance is very slight. In covering all of the local plant, the cost is less than three cents per station, so if these tests are made once a year, the costs represent but a fraction of one per cent of the total maintenance costs.

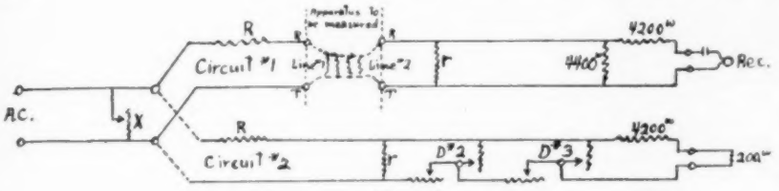


Figure 2
Circuit Diagram of Testing Set.

"In the toll plant the value of transmission is much higher. If the toll lines of Indiana, 68,000 circuit miles in all, were designed for only one mile higher equivalent, the plant costs would be reduced by $238,000 per year. This represents a saving of $3.50 per circuit mile per year, whereas transmission tests on toll lines cost, on the average, less than fifteen cents per circuit mile, including the cost of clearing trouble.

Testing Instruments Are Described

"We will now consider briefly some of the instruments used in making transmission measurements. The first method for determining the transmission efficiency of circuits and equipment was by means of talking tests, using artificial cable for comparison. This method was very slow and expensive to use on a large scale in transmission maintenance, consequently the 1-A transmission measure set, with its associated 2-A oscillator, was developed in 1916.

"First, let us look at the simplified circuit diagram of this set.

"The oscillator furnishes an 800 cycle tone that is a mean of the voice frequencies, which range from about 200 to 2,400 cycles per second. This tone is connected to the measuring set at the upper left hand binding posts. The shunt marked "X" regulates the input to the set and is adjusted by dial No. 1 to desired volume, as most testers can compare weak tones to a much greater accuracy than loud tones. Now there is a branched path, circuit No. 1, containing the apparatus to be measured and circuit No. 2 containing a calibrated network. By means of key No. 3 on the set, circuit No. 1, then circuit No. 2 can be connected to the tone. Dials No. 2 and No. 3 are adjusted until the same volume of tone is heard in the receiver over either circuit, then the loss is read directly on these dials to an accuracy of one-half mile.

"As seen from the circuit diagram, it is necessary to have four terminals, that is tip and ring of both ends of the circuit, for connection to the set. For cord circuits or pieces of equipment both ends are available at the testing point and the losses can be read directly, but for trunk circuits or toll lines, there is only one end of the circuit available.

Use of Set in Measuring Line Circuits

"A special method called triangulation of circuits must be used for these cases. This is shown in Fig. 3. Select three circuits between the points at which tests are to be made. At the distant end loop circuit No. A to circuit No. B by means of jumper wire,

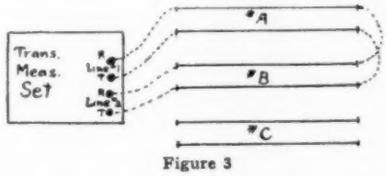


Figure 3

then both ends of a built-up circuit are available at the test set. For example, assume the reading with A and B connected as sixteen miles. Next, with A and C then B and C looped together at the distant end, assume the readings as fifteen and nineteen miles respectively. Then we have three equations with three unknowns and by solving these equations can find the transmission loss on any one circuit.

$$A + B = 16 \text{ miles}$$
$$A + C = 15 \text{ miles}$$
$$B + C = 19 \text{ miles}$$
$$\text{Add. } 2A + 2B + 2C = 50 \text{ miles}$$
$$\text{or } A + B + C = 25 \text{ miles}$$
$$\text{But } A + B = 16 \text{ miles}$$
$$\text{So subtracting } C = 9 \text{ miles}$$
$$\text{Likewise } B = 10 \text{ miles}$$
$$A = 6 \text{ miles}$$

"Now, if the length and gauge of these circuits is known, we can determine by the transmission equivalent just what loss should have been obtained for each circuit; thereby from a comparison of calculated to measured values can tell if there is an excess loss on any of them.

Cord Circuits Tested Yearly

"In the exchanges all cord circuits should be tested at least once a year, for they are the most common source of excessive transmission losses. Both ends of the circuit are readily available to the measuring set, but instead of four wires being brought out to binding posts, there are two plug connections. These plugs are inserted in their proper jacks at the right side of the set. The normal loss on "A" cord circuits is one and three-tenths miles, but in making initial tests in smaller exchanges, especially where the switchboard is old and not of standard type, it is not at all uncommon to find more than twenty per cent of the cords with losses above five miles. I understand that there are a few places where the old No. 8 repeating coils are still used in the plant. With the No. 8 coil in the cord circuit, the loss is about four miles, while with the standard No. 25 type coil the loss is only one and three-tenths miles.

"P. B. X. cords are also a frequent source of high losses, and these cords should be tested as often and in the same manner as those in main exchanges. The most common troubles found are poorly adjusted relays; interchanged tip, ring and sleeve connections; grounds or short-circuited turns in repeating coils; and cut-outs in the cords, usually in the plug connections. In order to insure that these serious troubles are not in the plant, it is advisable always to make tests on all new installations and whenever changes are made. These tests should be made before the new construction or changes are put into service, but in any event as soon afterward as possible.

"All telephone companies should own or have joint ownership in some transmission measuring apparatus. The 1-A transmission set is best suited and can be purchased by any telephone company. The cost of the set is $335, and the oscillator $80. For some of the smaller companies, this would be quite a sum to pay, especially since they would have use for the set but a small per cent of the time. In such cases it would be advisable for several companies, or an association, to buy a set jointly, then it would soon pay for itself.

"The latest development in transmission measuring instruments is the 3-A transmission set, with its associated 3-A oscillator. The principle of operation is quite similar to that of the 1-A set, as a comparison is made between the current through the apparatus to be measured, and the current through the calibrated network.

However, instead of comparing two tones by means of listening in a receiver, the current through each branch is compared on a galvanometer. Both the oscillator and set require twenty-four volts battery supply for their operation. As the measuring current is but a fraction of one mil-ampere, this alleviating current is rectified and amplified many times by means of two 101-B vacuum tubes, so fected for making transmission tests on operator's sets, but sixty to seventy-five per cent of the excess losses that the current will give a readable deflection on the galvanometer.

"The maintenance of operator's telephone sets is also highly important, for it is economical to provide operators even better transmission on their circuits than is given to subscribers. An instrument has recently been percan usually be remedied by visual inspection. It has been determined that these visual inspections are warranted once each month on all operator's sets. The main troubles to look for are defective cords, bent or rusty diaphrams, projecting pole pieces, defective plugs, and foreign material in the receiver or transmitter, such as chewing gum, hairpins, etc.

Inductive Noises Make Poor Transmission

"In order that telephone conversation will be clearly understood, it is not only necessary that the circuit have a given electrical efficiency, but it is also necessary to protect each telephone circuit from all sorts of other electric currents which tend to flow in the circuit. The principal source of difficulty is not from accidental contact of other circuits, but from what is technically called 'electric induction.' This comes about from the fact that any circuit carrying a variable electric current makes its presence felt at a distance.

"Now, the first and most important interference problem is the prevention of interference between two telephone circuits on the same pole line. When the first toll line was built from New York to Philadelphia, an engineer at the New York end started talking on pair 1-2 and said 'Get me all right?'

"'Yes,' answered the man at the other end.

"'All right, fine. Now meet me on pair 3-4.'

"'That's what I am listening on now,' the other engineer quickly replied. And they found that they could hear equally well on any pair, convenient in some ways but not very convenient in others. So one of the problems which has to be met is the avoidance of interference between telephone circuits themselves. The severity of this condition is perhaps brought out from the fact that the neutralization of inductive effects between two telephone circuits must be so exact that not more than one-millionth of the electrical energy of one circuit is transferred to the other circuit. This interference is called 'crosstalk,' and its effects are neutralized by properly transposing the telephone circuits.

be ready for use within six months.

"Where an unbalance exists between telephone circuits, then the inductive effects from neighboring power lines will be much more serious in the telephone circuits. The power circuit may be carrying as much as 10,000 kilowatts, which is approximately 1,000,000,000 times as much energy as the telephone circuit carries; so it is evident that even an exceedingly small amount of energy transferred to the telephone circuit from the power circuit would be enough to make conversation impractical. To a very large extent, this interference can be avoided by a properly coördinated transposition scheme.

"For many years this problem was handled almost entirely by telephone men doing things to the telephone plant, which made it less and less effected by the power induction; but in the last few years power lines have been increasing rapidly in number and intensity of power transmitted, so that it has become necessary to ask the help of power men also, in the prevention and reduction of these disturbing effects. So now telephone companies have relations with the National Electric Light Association, an association of the more important power companies of the country.

"There are two fundamental requirements to be kept in mind in considering the inductive interference situation. (1) Prevent the further growth of bad conditions. (2) Gradually clean up existing conditions. The whole essence of good relations hinges on coöperation, and this necessitates a square deal reasonably handled.

Stop Interference Before It Happens

"The proper time to handle the question of interference for new construction is while the new construction is still in the paper stage, and before equities have been established. Power lines are now springing up rapidly over this state, and all of you will have to meet these conditions to some extent. In many states the commissions have laid down rules governing parallels and conflicting construction, while in other states telephone and power companies have entered into agreements, formulating their own regulations. Just a few days ago the engineer of the Indiana Public Service Commission appointed a committee of power, electric railway, telephone and telegraph men to formulate a set of rules and regulations for joint and parallel construction in Indiana.

"We have interference, of course, from other sources than power and other telephone circuits, such as telegraph circuits, lighting circuits and wireless stations. The latter source of trouble is now increasing at an alarming rate since the late practice of broadcasting has been established. There are also several commercial stations that have been erected lately. The Federal Government now has under way the control of all amateur radio stations, for trouble is experienced mostly from smaller stations having non-standard equipment and using the spark method of sending instead of the continuous wave.

"In connection with the proper maintenance of the toll plant, it is essential that we know the noise and crosstalk conditions of the toll circuits, as such are very useful as an indication of the balance in the circuit. Periodic noise and crosstalk tests should be made on all toll circuits in conjunction with the transmission tests.

"Telephone transmission has been considered of such importance that over a half million dollars has been spent within the last few years for educational purposes alone by the telephone companies throughout the country. As a result of this campaign, practically a thousand men are now devoting their time primarily to telephone transmission problems.

"A system as complicated as the telephone plant cannot be expected to continue to operate at high efficiency without a definite transmission program, so that continual vigilance is the price not only of progress, but of keeping the plant where it was when built. Let me remind you of the little incident in "Through the Looking Glass"—where the Red Queen took Alice by the hand and began to run very fast. Alice got very much out of breath, but the Red Queen only ran the faster, and in spite of the pace, they seemed to be staying in the same spot. When finally they stopped for breath, right where they had started, Alice said: "Why is it necessary to run so fast? In my country when people run as fast as this they generally get somewhere." The Red Queen replied proudly: "But in our country you have to go twice as fast as that to stay where you were." This can be applied to our maintenance problem; a high degree of activity is necessary to keep the telephone plant in the condition called for by our high standards of service."

Exchange Area Transmission

Exchange Area Transmission Must be Guarded to Give Good Service—Many Small Details Vital in Makeup of Good Transmission and All Must be Watched Carefully

By L. S. Lambert

Division Maintenance Supervisor, Northwestern Bell Telephone Company

(Courtesy The Northwestern Bell)

The problem of telephone transmission is to send speech sounds over the telephone lines so that these sounds delivered at the receiving end will be sufficient in volume to be easily heard and readily recognized. The problem of exchange area transmission maintenance is to maintain the plant so it will give the transmission efficiency for which it was designed.

Since the telephone was first introduced to the public many wonderful developments in transmission have taken place. With each development the public has been educated to expect a higher grade of transmission. Fortunately an intimate knowledge of all of them is not required in maintaining the plant, but it is necessary to bear in mind that the principles have been taken into account in the design and manufacture of equipment and in the design of the circuits.

Transmission Must be Good

There is no hard and fast rule governing the proper values of telephone transmission, but from the standpoint of the subscriber, transmission must be good enough to permit of easy conversation, requiring no repetition. From the standpoint of the Telephone Company it should be sufficiently good to satisfy the subscriber's requirements and encourage him in the use of the telephone. These ideas are carried out in the design of all exchange plants.

In determining the efficiency of a telephone circuit, the circuit under observation and the standard circuit are talked over in turn and the amount of artificial cable in the standard circuit is adjusted to give the same volume of sound as is received over the circuit under test. The amount of cable inserted in the standard circuit to give this balance is then stated as the "transmission equivalent" of the circuit tested. The equivalent of this circuit is thus expressed in telephone terms as a certain number of miles of standard cable.

Ordinarily the standard for local exchange transmission lies between eighteen and thirty miles. This means that two subscribers talking to each other over the longest lines in the exchange should hear as well as though they were talking over a circuit with thirty miles of No. 19 gauge cable between the sets.

Wrong type of equipment, faulty equipment, missing equipment, incorrect wiring, open wiring, wiring crosses, cut outs, and high resistance connections are a few of the items which must be watched for from a maintenance standpoint.

Sources of Trouble Must be Watched

In the outside plant the cable pair, open wire, p. o. d. drop, fuses and heat coils must all be closely watched as they are sources of transmission troubles. To a certain extent the transmission equivalent of this part of the subscriber's circuit varies with the resistance of the component parts, and anything which tends to increase the resistance will also increase the transmission loss. High resistance connections must, of course, be kept out of the circuit, because they introduce into the circuit an unnecessary transmission loss and are unreliable.

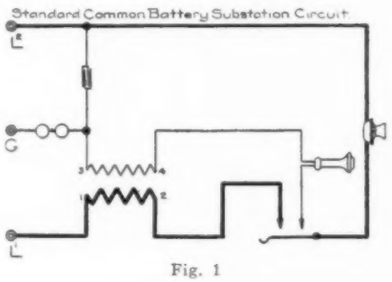


Fig. 1

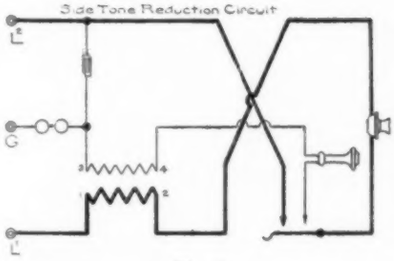


Fig. 2

At the subscriber's station the type of equipment used is of the two classes, magneto or common battery. Both sets, however, use the same types of transmitters and receivers. There are several types of transmitters and receivers in the field at this time and the later types afford more efficient transmission than the older ones. On long distance exchange lines where the transmission losses are necessarily high in the line itself the latter type transmitters and receivers are sometimes used. On exceptionally long loops in common battery exchange areas, transmission may also be improved by the use of subscriber's sets provided with dry batteries for supplying current to the transmitter. However, when this method is used, care must be taken to insure that the receiver is properly poled. Otherwise the receiving qualities of the instrument will be greatly reduced as a result of the current from the central office battery flowing through the receiver and tending to demagnetize the receiver.

A subscriber's loop may be so long that transmission is poor, but it also may be so short that transmission is not good due to what is known as side tone. Side tone is the noise produced in the receiver of the subscriber's set by sound waves acting on the transmitter of that set. It is always present in the standard substation connections and becomes objectionable when of sufficient volume to disturb the subscriber.

Side Tone May Cause Loss

As the efficiency of subscriber's station apparatus is increased the avoidance of excessive side tone is of increasing importance. Side tone produces several effects. Room noise which is picked up by the transmitter tends to disturb the subscriber. Loud side tone momentarily reduces the sensitiveness of his ear so that immediately afterward he is less able to understand the incoming transmission.

To protect his ear he lowers his voice, thus reducing the effective transmission volume. Side tone may be reduced by using the side tone reduction connection as shown in Figures 1 and 2. The side tone reduction connection decreases the transmission efficiency of the subscriber's set about 3½ miles.

The connection on the induction coil in the subscriber's set must be in accordance with the design of the circuit, because the windings bear a definite relation to each other and unless they are connected in accordance with their design high transmission losses will result.

Run Down Batteries Reduce Efficiency

At subscriber's stations where local batteries are used it is important that the cells be renewed when they have discharged to a point where insufficient current is supplied to the transmitter. This point can be determined by talking with the subscriber or by testing the batteries with battery gauges. It is of the utmost importance from a maintenance standpoint that the batteries be watched closely, as the subscriber does not know that his batteries are weak until they have discharged to a point where it becomes almost impossible for people to hear him.

Batteries at local stations are usually replaced by exchange repairmen. Those at rural stations are most economically replaced by the subscriber after his transmission has been found poor. Batteries are then mailed to him, with the request that he replace the old cells. When this is done the transmission improves.

In order to obtain the best batteries for this purpose, tests are continually being made of the principal makes of dry cells on the market. To insure the tests being of value in determining the life of dry cells when used for telephone service it is necessary to simulate as nearly as possible actual service conditions. This is done by use of a mechanism which automatically closes the circuit through the proper resistances to give about the same discharge as would occur in service for periods of about the length of the average telephone conversation, at intervals which simulate service conditions as closely as possible.

Losses Also Occur in the Exchange

Because of the great amount of equipment and wiring in the central office great care must be taken to avoid excessive transmission loss. In designing apparatus its use is taken into consideration and it is designed to give a minium loss for that use. Relays are designed to be used in series or in shunt and a relay which was designed to be connected in series in a talking circuit would cause an excessive loss if it were connected in shunt across the circuit. Likewise repeating coils and retardation coils are designed and manufactured to be connected into the circuit in a certain manner and unless they are connected in this way excessive losses are likely to result. Certain relays have non-inductive windings for the purpose of carrying voice currents. Although an open in the non-inductive winding on such relays would probably not materially affect the operation of the circuit it would appreciably increase the transmission loss.

Circuit drawings show the proper connections to be made to various pieces of apparatus in the circuit. Whenever it is necessary to replace defective apparatus care should be taken to connect the new apparatus in accordance with the drawing.

Examples of transmission losses due to faults mentioned in the foregoing, are as follows:

The transmission equivalent of a Western Electric No. 118-A relay connected in series in a No. 1 cord circuit is approximately .3 of a mile, but with the non-inductive winding open it is increased to three miles.

A type B-19 relay connected in series in a circuit gives a transmission loss of approximately .3 of a mile, but if connected in shunt produces a transmission loss of nearly twenty-two miles.

In a Western Electric No. 1 switchboard cord circuit with all equipment properly wired the transmission loss is approximately 1.2 miles. With an open non-inductive winding on one of the supervisory relays the loss is increased to more than three miles. In this same circuit if the normal connection to points 1 and 2 on the repeating coil are reversed the transmission loss of the circuit will be increased so much that it will be almost impossible to talk over the circuit.

Troubles experienced at p. b. x. switchboards are of course similar to those which may be experienced at the central office board. It is necessary here, also, to watch carefully that equipment is connected in accordance with its design.

In large exchange areas where more than one exchange is necessary, trunks and order wires are used between exchanges. In designing these trunks and order wires care is taken to obtain a certain transmission efficiency, and in order to do this it sometimes becomes necessary to place load coils in the circuits. It is necessary that these circuits be tested periodically in order to guard against defects similar to those which occur on subscriber's loops and central office equipment.

Original Hughes Microphone Found in London

London, Eng.—In a letter to The Times, Mr. A. A. Campbell Swinton states that in addition to David Hughes' notebooks containing an account of his experiments in wireless telegraphy in 1879, which have recently been bequeathed to the British Museum, the museum has acquired a further set of these notebooks, containing Hughes' own illustrated account of his invention of the microphone. "Still more interesting," states Mr. Swinton, "is the fact that a search, suggested by myself to Colonel H. G. Lyons, of the Science Museum, made amongst the contents of a room full of Hughes' personal effects that for the last twenty years have been stored in a furniture repository in London, has revealed the existence of a number of electrical instruments, comprising the original first microphones invented by Hughes, and the actual apparatus with which he made his early wireless experiments, all obviously constructed with his own hands. The several instruments can easily be identified by the illustrated descriptions in the notebooks, and we thus have a collection of great historical and scientific interest, which, through the generosity of the Hughes' trustees, has been presented to the Science Museum in South Kensington, where it will shortly be on public view."

R. A. Dalzell Named British Wire Director

London, Eng.—R. A. Dalzell, C. B. E. has been named to fill the new post of Director of Telegraphs and Telephones. Mr. Dalzell was born in Poona, India and educated in England. His connection with telephone work began in 1881 when he entered the service of the Globe Telephone Co.

Ernest P. Lasché, Formerly Bell Editor, Dies at St. Louis

St. Louis, Mo.—Ernest P. Lasché, editor of the Southwestern Telephone News, until July, when failing health caused his resignation, died recently in St. Louis while undergoing an operation for tonsilitis.

Trouble Comes Butt End First

Trouble has a trick of coming butt end first,
Viewed approaching you've seen it at its worst.
Once surmounted—then it dwindles small
And tapers till there's nothing left at all.

—Bell Telephone News.

Grounding Cable Protectors

Protected Cable Terminal of the All-Metal Type Calls for Thoughtful Consideration of Location of Grounds—Practical Plant Man Gives His Ideas

By Fred G. Pyle

At a meeting of plant men recently, there came under discussion the question as to the proper manner of providing the ground connection for a protected cable terminal of the all-metal type. The all-metal type of aerial cable terminal ordinarily, if not always, has a complete metallic connection between the ground strip for the protectors and the nozzle where the cable enters the terminal. One of the questions which came up was whether it was necessary to have a ground at each terminal in addition to the ground on the cable sheath. This brought up the second question as to the proper method of grounding under conditions when it is necessary to insulate the sheath of the aerial cable from ground.

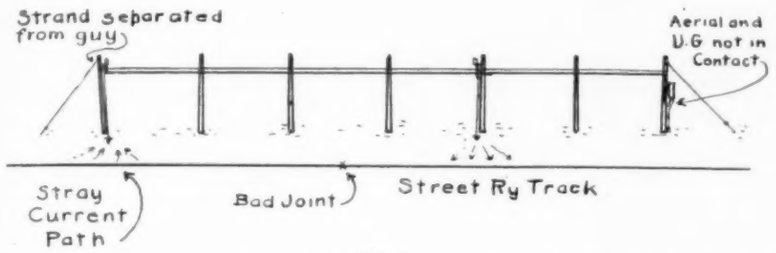


Fig. 1

There are a number of questions that must be considered in the solution of the problem. In the first place it must be conceded that it is ordinarily advisable to have the cable messenger and sheath insulated from ground where there is a possibility of electrolysis due to stray currents from the trolley return system. The sheath of aerial cable is insulated from the sheath of underground cable either by looping the cable in and out of a junction box or by the installation of an insulating joint. The messenger strand is insulated by separating the messenger and the guy strands at the terminal poles or by the use of insulators in exposed guy strands as called for by the National Electrical Safety Code. Under these conditions there would be no ground at all on the cable terminal and the protection would be useless.

If a ground were placed at each terminal as shown in Fig. 1, there would be a possibility of stray current entering the cable sheath and messenger at one point and leaving it at another point with the result that the ground wire at the point where the current leaves the cable through the ground wire would be corroded and eventually eaten off. This would leave the only ground on the messenger at the end.

From a study of these conditions the conclusion was reached that there should be only one ground on the aerial cable section and that ground should be located near the middle of the section whether or not a cable terminal happened to be near although ordinarily it would be placed at a terminal if one were near the center of the section. Figure 2 illustrates this arrangement.

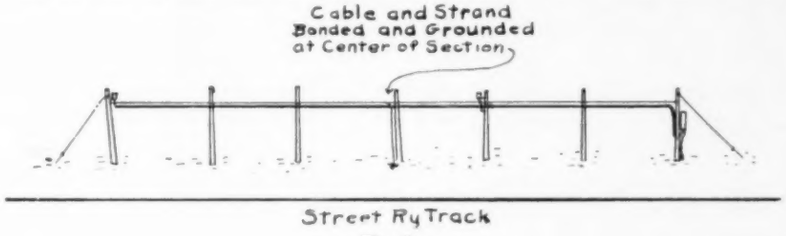


Fig. 2

Where metal rings are used, they are depended upon to furnish contact between the sheath and messenger but as an additional precaution where the cable sheath and messenger are used as the protective ground it might be well to bond the sheath and messenger together. Burns have been known to occur under the rings where this is not done. This bonding should be done at the point where the ground is made and perhaps at the end of the run of aerial cable, on the pole next to the underground junction pole if the section is a long one.

If, on the same section of cable, terminals are used both of the all-metal type and the type in which the ground strip is insulated from the frame it would be advisable to use separate grounds for such terminals as have insulated ground strips rather than to bond the ground strip to the frame. An individual ground is better protection than a ground on the cable sheath of the type described. The cable sheath ground, however, must be adopted for the all-metal type terminal for the reasons already given.

Argentine Ants Play Havoc With 'Phone Poles

Jackson, Miss.—The Argentine ant is playing havoc with the red cedar poles of the Cumberland Telegraph and Telephone Co., the Postal and Western Union Telegraph companies, and other public service corporations in Jackson. An inspection being made of the Cumberland poles in Jackson shows that more than one-half of them are so badly infested with Argentine ants that they will have to be taken down, the insects having eaten out large hollows at the base of each pole. The cedar poles of other corporations maintaining wire service in the city are equally as bad, and the destruction wrought involves a loss of thousands of dollars, aside from the fact that it is now practically impossible to secure red cedar poles. As a matter of fact, no poles of this kind have been erected during the past five years, the corporation having been forced to use creosoted pine. Thus far the pine poles have not been attacked by the Argentine ant, according to the report.

OPINIONS AND COMMENTS

TOLL REVENUE AND ITS DIVISION

The question of the revenue from toll and long distance service and its division between the toll and exchange plants has been under serious discussion in a number of places recently.

This matter has been brought into rate cases and has been discussed before conventions by association officers and has been discussed privately by many telephone men.

There seems to be a general impression among people on the outside of the telephone business and to a certain extent among men within the business, that the operation of the toll plant is a very profitable part of the telephone business. No doubt this has in a measure been caused by the anxiety of telephone officials in certain instances to keep the question of toll earnings and their division out of rate cases involving local exchange areas.

This opinion has led to the injection of the toll earnings issue into many rate cases and has led many managers of local companies to become dissatisfied with the commissions allowed by the long distance companies on originating business.

On the other side of the question, the Northwestern Bell Telephone Co. has introduced evidence in the Nebraska hearings to show that the earnings of the toll plant in that state represent a return on the investment of only 4.74 per cent,—if we remember the figure correctly. The officials of another company operating toll lines over a large area have said privately that they are willing to open their books to any connecting company to show that the toll plant is being operated at a loss.

There is opportunity for wide divergence in figures that may be prepared in the same data as the problem of distribution of toll earnings and expense is one of the most complex in telephone accounting. Where toll and local lines are operated in the same office there are many items of operating expense that can not be charged directly to either exchange or toll operation but which must be allocated between the two on some agreed basis. The allocation will depend upon the basis assumed and good reasons may be advanced for the use of any one of several methods. To a certain extent the same thing may be true of plant charges where both toll and exchange plant are operated by the same company.

There is room for careful study of this question to determine if more accurate methods of accounting may be applied but it must be remembered that increased accuracy will mean increased accounting cost and the point may be reached where the gain in accuracy will not justify the additional expense.

In any case the preparation of reasonable figures and frankness in presenting them will do much to clear away the existing misunderstandings.

There is one important factor in the whole question of toll earnings that does not seem to have been given consideration in any of the discussions and that is the relation of toll earnings to general business conditions. Telephone men are accustomed to thinking of the business as one that is affected very little by general business conditions. This is true as regards the business as a whole but is not at all true in regard to the toll portion of the business. Toll earnings are one barometer of general business conditions and they are subject to fluctuations that are similar to the fluctuations of the total volume of business of the country. When business is good, toll earnings increase and the return on toll plant investment is correspondingly greater. During a depression toll revenue decreases and the return on the investment is small or the plant may even be operated at a loss. The investment in toll plant is subject to greater risk than exchange plant not only by reason of its more exposed character but also because of the fluctuating character of the earnings. It is reasonable, therefore, that the average rate of return should be somewhat greater than the return on the exchange plant investment. Under the usual form of toll connecting agreement, both exchange and toll plant participate in the increased earnings when business is good and both suffer when the volume of business drops off, which is as it should be.

During the period of depression just passing, many exchanges undoubtedly have done their toll operating without profit just as toll lines or properties may have been operated without profit and on this account dissatisfaction has arisen which will tend to disappear as business improves.

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In exchange rate cases which have come up during the period of depression and where toll commissions have been estimated or toll earnings have been allocated on bases derived from figures of the period just succeeding the war, the figures are most certain to have been unfair to the company operating the local plant.

WASTE IN INDUSTRY

The manufacturing industries of this country are now being studied by the Engineers of the nation under the lead of Mr. Herbert Hoover, Secretary of Commerce, to determine to what extent the enormous waste that has been taking place may be reduced.

The survey conducted by the Federated American Engineering Societies indicates that very great economies are possible through the simplification of lines of manufactured products. Just now a survey is being made of the engineering and technical bodies that are willing to co-operate to determine what simplification in manufactured products in their fields is most needed and most desirable.

So far, we have heard of no action in the telephone field to cooperate in this movement but undoubtedly the telephone industry will be found to be in line when the work starts.

That much simplification is possible in the list of manufactured goods used in the telephone plants of the country, no one can doubt. Taking as an example pole line hardware, anyone who studies a supply catalog is struck by the great variety of sizes and kinds of certain items that are made and stocked by manufacturers and supply dealers. There is no doubt that a study of conditions would show that the demand for many sizes and kinds of material is very small and that they could be eliminated entirely without causing changes of any importance in present construction practice.

One of the items of cost is the interest on the investment and depreciation of material held in stock. Considerable saving could be made in this item alone if slow-moving sizes and types were discontinued and a few standard sizes only were carried. Manufacturers could concentrate on the production of the standard sizes in larger quantities and would save the cost of changing machinery for production of many sizes and the cost of carrying a stock of raw material of many different sizes. This would result in a decrease in price to the operating companies and a saving to all departments of the business.

In the telephone apparatus field, likewise, many simplifications could also be made in non-essentials. To mention only a few things, no two manufacturers use the same size and screw thread on transmitter mouthpieces; cord terminals are found in an endless variety. Screw sizes in various parts of the apparatus are not standardized and there are many other unnecessary variations. There would probably be little saving to the manufacturers if these things were simplified and standardized but the operating companies would profit from it. Operating companies must now carry much larger stocks of repair parts than would be necessary if these things were standardized. Time is often lost and repairs delayed because the particular size or kind of part is not in the repairman's kit.

It would be practically impossible to prepare figures to show the extra cost due to the lack of standardization in telephone equipment and construction material but there is no doubt that it represents a large sum annually when the entire industry is considered.

There are many industries in which the waste is greater than in the telephone industry. There are others in which waste is smaller. Whatever may be the position of the telephone business as compared to others—and we like to think that our business is operated efficiently—we must admit that avoidable waste may be present. By all means let us have a survey of our field so that we may eliminate every uneconomical feature that is discovered.

UNHONORED AND UNSUNG?

In Vail Medals for American Telephone and Telegraph Company employees for "noteworthy public service of such conspicuous merit as to justify special recognition" the Bell has a factor of untold value in building the esprit de corps and winning public good will.

Those employees to whom decorations have been awarded, and countless others in telephone service, have expressed the industry's constant fidelity to its public; by their actions beyond the ordinary boundaries of their duties.

It is a spirit that is a characteristic feature of the telephone industry, and some official recognition should be made of it by Independent companies; some recognition that would be to those workers in the Independent branch of the industry, what the Vail Medals are to those of the Bell family.

It might be well for the coming U. S. Independent Telephone Association convention to consider a Hall of Fame for those who are not eligible for the signal honor of a Vail decoration.

TWILIGHT FOR THE FLEECERS.

Women compromise the majority of stockholders of the Bell company. From allowances, independent incomes and earnings in business life, the thrifty women of America have placed the long green seal of their approval on telephone company securities.

It may be "woman's intuition," or it may be a sign of woman's development in commercial judgement, that is responsible for this leadership in telephone security holdings, but whatever it is, it indicates that the period of soft picking for the financial despoilers of the "widow and orphan" class, is about in its twilight.

Certainly this is a consummation devoutly to be wished by the men of the land.

Telephone financiers who are responsible for this great sale of substantial securities to women are to be congratulated upon their success in this field.

Reducing the "Don't Answer" Calls

New Invention of Signal Engineers for Developing Revenue Where Business and the Subscribers' Good-Will Suffers Now

By J. K. Moran

In some localities, especially in industrial centers and rural districts, the telephone systems remind one of a man who rushes after a trolley car only to have it stalled for half an hour after he breathlessly gets aboard.

The central offices of these telephone plants are equipped with every conceivable device for facilitating the quick and economical handling of calls. But the facilities for speeding up calls at the other end of the line are often neglected. The operator connects the number without losing a moment—but then comes a waste of time. She has to ring and ring. The party called is slow in answering or does not answer at all because he cannot hear the telphone bell.

The trouble is that customary telephone bells are used in too many places where a more powerful signal is needed. In noisy factories for instance the rattle of machinery often drowns the telephone bell. In warehouses, lumber yards, power plants, garages, farmhouses, etc. the men are often too far away to hear their call.

This Way Makes 'Em Answer.

Where subscribers have difficulty in hearing telephone bells a more powerful signal such as a signal horn or a large bell can be connected with the telephone ringing circuit. This larger signal can be operated either from batteries or from light or power current—with the aid of a telephone extension relay.

The subscriber usually rents the telephone extension relay and the signal. This not only furnishes the company directly with additional revenue without the necessity of adding to the central office or line equipment, but indirectly it brings profit in other ways too.

The telephone extension signal eliminates many "Don't-Answer" calls. A "Don't-Answer" call though it takes longer to handle than a regular call, brings no revenue. Turning it into an "Answer" call adds just that much to the profit. Also the subscribers get better service at both ends. The caller no longer has to wait, and the party called does not lose telephone calls because of inadequate signals. Then too, more calls can be handled with the same central office and line facilities because the time formerly wasted is saved

Best of all the telephone service of the entire community served, is better. There are less busy lines, and the operators answer more promptly. In short, the use of the telephone extension signal or relay, does all that good telephone equipment should do.

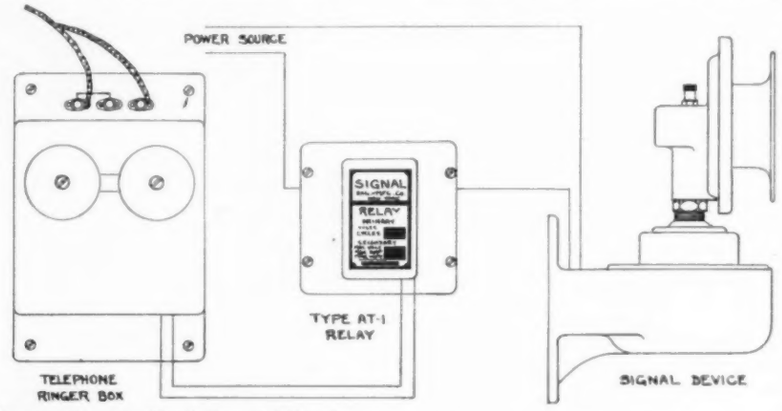

Diagram Courtesy Signal Eng. & Mfg. Co.

Here's How the Signal Extension Relay is Wired

1. It increases the efficiency of the operators.
2. It betters the service to subscribers.
3. It turns many losses—"Don't-Answer" calls into revenue-"Answer" calls.
4. It increases the revenue without the increase of central office or wire facilities.

Great care must be taken to make sure that the telephone extension relay and the signal used are both thoroughly reliable. They should operate day in and day out without attention so that the maintenance expense of the subscriber's operating station will not be increased.

The relay when used on common battery lines should be connected across the lines in series with a two microfarad condenser. A two microfarad in the standard telephone set is sufficient when it is desired to replace the ringer with the loud signal. However, where the ringer is retained but is supplemented with a loud signal, an additional two microfarad condenser should be employed.

The relay should have enough impedence to prevent its interfering with the operation of other apparatus on the same line and so that it will not interfere with the operation of the tripping relay on machine ringing circuits. Furthermore, telephone extension relays should stand a break-down test of 2500 volts so that there will be no danger of a cross between the telephone circuit and the power circuit. In this respect they must meet the Underwriters' requirements.

Where installed outside or in damp locations, or any locations where acid fumes are prevalent, the relay should be mounted in weatherproof housing.

N. T. Guernsey Says Phone Shortage End Distant

San Francisco, Cal.—N. T. Guernsey, Vice President and General Counsel of the Bell system, in an interview at the American Bar Association convention, says it will be at least another year before telephone companies again will be in a position to anticipate telephone requirements. The war's aftermath still is being felt by the industry.

Not including the thousands engaged in the making of telephone equipment, there are about 300,000 men and women engaged in the telephone industry. About 170,000 are operators.

Los Angeles Force Doubles in Two Years

Los Angeles, Cal.—More than double the number of people employed in 1920 now are on the payroll of the Southern California Telephone Co. here. The staff now numbers 6,589.

Belleville, Kans. Gets New Exchange Building

Belleville, Kans.—Within the next few months the United Telephone Co. will have completed a new $10,000 telephone exchange building here.

Valuation in Rate Making

Chapter VII—Inventory of Subscribers' Station, Central Office, General and Miscellaneous Equipment

By Charles W. McKay, Associate Editor

In the August installment, we completed our consideration of ways and means of recording the inventory of the outside plant. The inventory of the subscribers' station, central office, general equipment, etc., is much less difficult—in that it does not involve the use of specially designed forms and, furthermore the equipment to be inventoried is concentrated in one location. This latter statement, of course, does not apply to the subscribers' station equipment—i. e., the subscribers' station equipment is not concentrated in one location—but the inventory of this portion of a telephone property is simplified by the fact that it is not necessary to make an actual count of all of the subscribers' stations.

Central Office Telephone Equipment

The inventory of the central office equipment should be divided into the following classifications:

1. Telephone switchboards.
2. Main and intermediate frames.
3. Switchboard cables.
4. Central office power plant.
5. Auxiliary central office equipment—wire chief's desks, supervisors' desks, etc.
6. Miscellaneous central office equipment.

All of the above equipment falls under the Interstate Commerce Commission Account 221, "Central Office Telephone Equipment." To refresh the reader's mind, it may be well to quote the Interstate Commerce Commission's instructions as to this phase of the inventory problem.

"This account (Account 221) should include the cost of local and toll switchboards, chief operator's desks, monitors' and supervisors' desks and tables, wire chiefs' testing outfits, main and intermediate frames, cables and jumper wires, call registers or meters, relay racks and coil racks and power plants, including rectifiers, generators, engines, motors, batteries, power switchboards, meters and fuse boards; telephone and telegraph instruments and other electrical instruments and apparatus in the central office devoted to the operation of the telephone plant."

The following illustration, taken from a recent appraisal, will serve to illustrate how the central office equipment should be recorded.

Switchboards

Type: Stromberg-Carlson common battery; full multiple lamp signals, three positions, six panel sections.

Capacity: 2,400 multiple subscribers' lines, 600 answering jacks per section.

Equipment: (1) Toll section equipped with 1,100 subscribers' multiple jacks, 40 rural multiple jacks, 20 long distance multiple jacks, 10 special multiple jacks, 16 L. D. answering jacks, 1 calculagraph and 2 operators' positions. Each toll operator's position equipped with 8 toll cord circuits. Rural and local sections equipped with 1,100 subscribers' multiple jacks, 10 rural multiple jacks, 50 special multiple trunk jacks, 60 rural answering jacks, 170 local answering jacks and 2 rural and local operators' positions. Each of the rural operators' positions is equipped with 15 pairs rural cord circuits, and the local position is equipped with 15 pairs local cord circuits.

(2) Local sections being equipped with 1,100 subscribers' multiple jacks and 50 special multiple trunk jacks. These two sections are also equipped with 950 local answering jacks, 4 regular operators' positions and 1 special operator's position. Each of the regular operators' positions is equipped with 15 local cord circuits and the special operator's position with 9 pairs local cord circuits and 1 test cord circuit.

Frames and Racks

In recording the inventory of frames and racks, somewhat the following form should be used:

Main Frame—

Type: Stromberg-Carlson Mfg. Co. Standard Angle Iron Frame.

Capacity: 2,080 pairs of protectors.

Equipment: No. 60 Cook protectors for 1,500 lines.

104—25 pair terminal strips.

Relay Rack—

Type: Stromberg-Carlson Standard Angle Iron frame.

Capacity: 1,920 lines.

Equipment: 1,400 lines.

Cable Racks 30 ft.—6-inch, iron cable racks.

Wire Chief's (Testing) Equipment; Monitors' and Supervisors' Desks, etc.

1 Wire Chief's Desk, consisting of:

1 Stromberg-Carlson Telephone Mfg. Co. standard sanitary type, No. 1 position desk complete with drawers, etc.

2 testing trunks to local switchboard.

2 testing trunks to toll test panels and toll board.

2 testing trunks to main frame.

1 wire chief's testing circuit.

1 testing voltmeter—Western Electric Company, Model 45 D. C., double scale O—15, O—150.

1 100-ohm voltmeter shunt.

2 lines from local board.

4 desk lines to chief operator, toll board, manager, etc.

1 wire chief's telephone circuit-suspended arm type.

4 order wire circuits.

1 line pilot circuit.

1 master key, etc., etc.

1 Recording and Information Desk, consisting of:

1 sanitary flat top desk complete with drawers.

10 incoming recording trunks.

4 information trunks.

4 desk lines for chief operator, wire chief, manager, etc.

1 operator's breast type telephone circuit complete.

1 attention signal circuit.

Switchboard Cabling

It will be remembered that the central office terminating cables—the cables extending from the potheads, in the basement of the central office, to the main frame—are included with the exchange underground cables, and are so inventoried. All cables between main and intermediate frames and between the frames and the switchboard, however, are a part of the Central Office Telephone Equipment (Account 221) and should be so inventoried. Such cables should be cata-

loged according to size (number of pairs) and gauge of wire and the length should be measured and recorded.

Power Plant

Great care should be exercised in recording the inventory of the power plant—as this portion of the central office equipment (at least in the case of the larger offices) represents an appreciable investment. The following general form for recording the data is suggested:

Machines

1 Westinghouse, 50 ampere, mercury arc rectifier.

1 duplicate set of Garford 4 vibrating units with transformers, etc., for delivering A. C. ringing current at 16⅔, 33⅓, 50 and 66⅔ cycles, respectively.

1 motor driven, 110 volt, 60 cycle interrupter.

1 relay interrupter.

1 flash recall machine on interrupter machine.

1 flash recall machine on 22 volt battery meter.

Switchboard (Power)

2 36"x36"x1¼" slate panels.

5 36"x24"x1¼" slate panels.

1 Cutler-Hammer circuit breaker.

3 single throw, two point, 30 amp., 250 volt knife switches.

2 double throw, two point 30 amp., 250 volt knife switches.

1 single throw, three point 60 amp., 250 volt knife switch.

3 double throw, three point 30 amp., 250 volt knife switches.

2 rotary switches.

1 Weston voltmeter scale O-75.

1 Weston ammeter—scale O-100.

1 service panel complete with fuse equipment.

Storage Batteries

1 Chloride Accumulator consisting of:

11 No. 11F elements.

11 No. 17F glass jars.

Electrolytes, etc.

2 Chloride Accumlators, for toll booster, each consisting of:

11 P.T. elements.

11 P.T. glass jars, etc., etc.

Miscellaneous

The miscellaneous equipment consists of the operators' chairs, etc., and should be listed in somewhat the following form:

Chairs

6 18" standard S.-C. Co. operators' chairs.

11 24" standard S.-C. Co. operators' chairs.

1 Swivel straight seat chair.

Other Equipment of Central Offices—Account 222

To review the instructions of the Interstate Commerce Commission, "This account should include the cost of furniture and equipment (other than telephone equipment) in central offices for the operators' forces. This includes the furniture and equipment in operators' rest, lunch rooms and in operators' schools."

There is little to be said in connection with this phase of the central office inventory problem. Nearly every up-to-date telephone central office is equipped with a rest, or retiring, room for the use of the operators, and in many cases lunch rooms are provided. Obviously, all of the equipment included in the rest and retiring rooms—and in the lunch rooms—should be cataloged under the general caption "Other Equipment of Central Offices—Account 222."

Subscribers' Station Equipment

To conform with the instructions of the Interstate Commerce Commission—and with the instructions of most of the State Commissions—the subscribers' station equipment must be divided into two classifications, "Station Apparatus" and "Station Installations."

Station Apparatus

To review the instructions of the Interstate Commerce Commission—"This account (Account 231) should include the cost of station apparatus, such as telephone sets, intercommunicating sets, bells, blackboards, desk stands, coin boxes, protectors, battery boxes, special station switching devices not otherwise classified, and telephone and telegraph instruments, or parts thereof, when owned by the company and installed for service."

Needless to say, the task of visiting and inspecting all of the subscribers' stations—in even a small telephone plant—would impose a well nigh impossible task upon the appraisal engineers. It is customary to obtain the necessary information as to subscribers' apparatus from the telephone company's records and to supplement this information by a field check of from 10-15% of the total number of instruments involved.

It will usually be found that companies have excellent records as to the types and quantities of station apparatus. In so far as the station apparatus itself is concerned, the purpose of the percentage inspection is to obtain the present condition and to verify—in so far as possible—the company's records as to size and make of the apparatus. In making this percentage check, in the field, care should be exercised to select stations at random including an equal number of city business stations; city residential stations and rural stations. This phase of the inventory problem is so closely allied to the inventory of the "Station Installations" that we will consider the two together.

Station Installations, Account 232

"This account (according to the Interstate Commerce Commission) should include the cost of installing apparatus and the cost of inside wire, that is the wires (or cables) from the instrument to the point of entrance to the building, where the drop wires terminate; or to the injunction boxes where the house cables or other cables

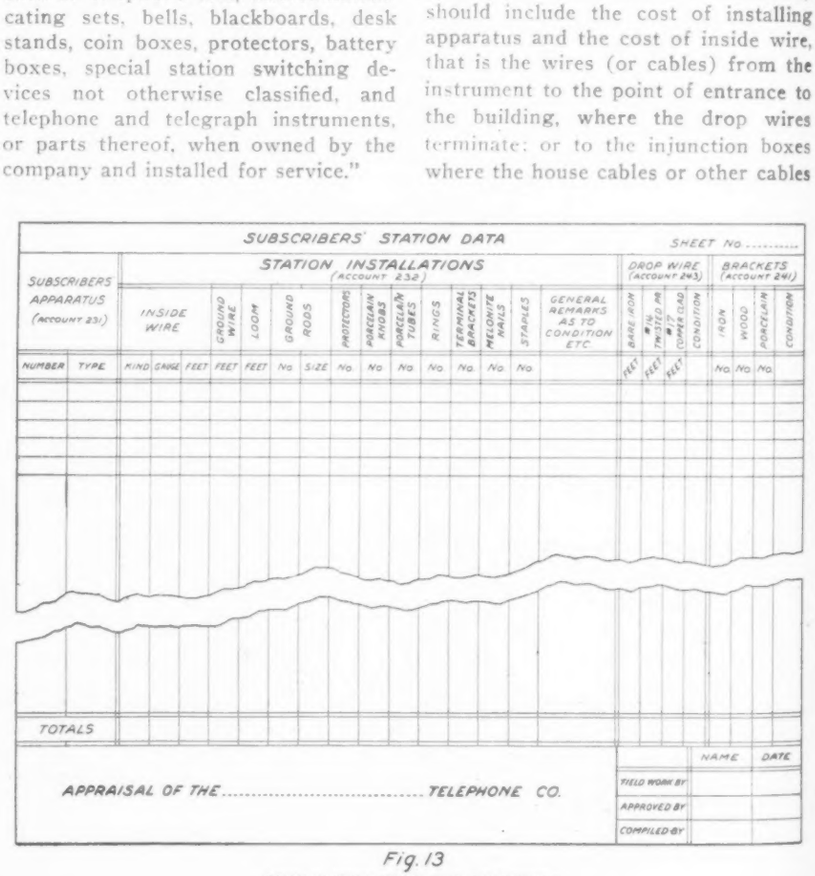

Fig. 13
COMBINATION FORM FOR RECORDING SUBSCRIBERS' STATION AND DROP WIRE DATA

terminate including wires on the same premises to connect main and extension stations; or to connect private branch exchange distributing frames with their terminal stations."

As previously pointed out, in connection with the section on aerial wire (243) the drop wire is really a part of the aerial wire—in other words, a part of the outside plant. The drop wire, however, terminates at the protector mounting (in such cases where station protection is used), or at the terminal block, at the subscriber's premises. From this point on toward the subscriber's station all of the wire is chargeable to station installations, Account 232. The percentage check of the subscribers' station equipment will afford sufficient information so that the appraisal engineer can estimate the average amount of wire used for residential subscribers' stations and the average amount of wire used for business subscribers' stations, etc.

Many appraisal engineers favor a combination form—such as is illustrated in Fig. 13—for recording the subscribers' apparatus, the subscribers' installation and the drop wire information — in connection with the percentage check. Subsequently the drop wire information can be drawn off of these forms and transferred to that portion of the inventory which has to do with the outside plant.

Referring to Fig. 13, in making the percentage check, the following information should be recorded regarding the instrument.

The make of the instrument—whether Kellogg, Stromberg-Carlson, Western Electric, etc.

The manufacturer's identification or code number.

The type of instrument—whether of the desk form, wall form or "hotel" form, and, of course, whether common battery or magneto.

The condition of the instrument.

In connection with the Station Installations, the inspector should note:

The gauge and type of wire used.

The length of wire.

Size and length of ground wire.

Size and type of ground rod.

The approximate amount of miscellaneous material used, such as melonite, nails, protectors, knobs, staples, connecting blocks, etc.

The condition of the inside wiring.

The method of recording this data can be readily determined by referring to the field form illustrated in Fig. 13. The information recorded will be found of great use, subsequently, in building up the apparatus and station installation unit costs.

Private Branch Exchanges, Account 234

Quoting the Interstate Commerce Commission: "This account (Account 234) should include the cost of private branch switchboards, their distributing frames, the cables connecting such switchboards and distributing frames and the cost of installing this switchboard and auxiliary equipment."

In the case of the smaller telephone plants, comparatively few private branch exchanges will be found—and it is therefore a simple matter to make detailed inspection of the private branch exchange equipment. In any event—even in the case of the larger telephone properties—it is a good plan to inspect all of the private branch exchanges. No special forms are needed for recording the data—but, of course, the size and capacity of boards should be noted; the make of boards; the manufacturer's identification or code number; the terminal equipment and the sizes and lengths of special cable used in connection with the installation.

Booths and Special Fittings, Account 235.

"This account" (according to the instructions of the Interstate Commerce Commission) "should include the costs of booths and special fittings, such as desks, chairs, fans, cash registers and the cost of installation."

If the plant is a small one, it will usually be found that there are very few booths and special fittings—such booths being located in hotels, railway stations and other public places. In such cases — where the amount of equipment involved is not appreciable—it is a good plan to make a detailed inspection of each installation. In the case of the large cities, however, where nearly every drug and cigar store has a booth, it is, of course, out of the question to make a detailed inspection—and the "percentage-check" method must be used—as in the case of the subscriber's apparatus and subscribers' installations. A fair percentage—say, 5% or 10% of the total number of the booths involved—should be inspected in detail and a careful record made as to all of the equipment involved. The rest of the information may be obtained from the company's records.

General Equipment.

General Equipment—Account 260—includes the following sub-accounts:

Office furniture and fixtures. Account 261.

General shop equipment. Account 262.

General store equipment. Account 263.

General stable and garage equipment. Account 264.

General tools and implements. Account 265.

The "common sense" method should be used in inventorying this portion of a telephone company's property. As much detail should be recorded as seems necessary without wasting time and increasing the cost of the appraisement beyond a reasonable figure. Such items as office furniture and fixtures—and stable and garage equipment—should, of course, be inventoried in detail.

We will review the instructions of the Interstate Commerce Commission for each of the sub-accounts — with the thought that it will aid the student in gaining a clear understanding of what the accounts include, and how the inventory should be handled.

Office Furniture and Fixtures.

"This account should include the cost of desks, tables, chairs, carpets, cases, movable partitions, railings, shelves, typewriters, addressing machines, adding machines and other office devices; stoves, portable gas and electric fixtures and other fittings (except fittings considered a part of the building and provided for in Account 212, Buildings, and telephone equipment provided for in Account 220, Central Office Equipment)."

General Shop Equipment

"This account should include the cost of all equipment especially provided for general shops, such as engines, gas producers, electric generators and other power apparatus used in operating machinery in such shops; machine tools, shafting, belting and like shop equipment.

"Hand and other small portable tools—liable to be lost or stolen—should not be included herein, but portable tools and apparatus of special value may be charged to this account, and remain herein so long as a record is kept of such tools and apparatus."

General Store Equipment

"This account should include the cost of all equipment of general store structures, such as movable counters, movable shelvings and other movable equipment of like nature; carts, wheelbarrows, trucks, tools, etc., and other apparatus and appliances used in handling, storing and packing materials and supplies. Counters, shelving and the like which are permanently attached to the structure should be charged to the account 212, Buildings, and not to this account."

General Stable and Garage Equipment

"This account should include the cost of all equipment of general

stables, including horses, harnesses, drays, wagons, automobiles and other vehicles; equipment used for harness repairs, vehicle repairs, automobile repairs, etc."

As previously suggested, of course all of the stable and garage equipment —with the possible exception of the minor items—should be carefully inventoried. All trucks and automobiles should be properly described and classified.

General Tools and Implements

"This account should include the cost of portable testing apparatus and valuable tools and implements devoted to the maintenance, or construction, of the telephone plant and not provided for in the equipment accounts. This does not include tools not yet in use, and supplies unissued."

The foregoing is also qualified by the statement "Hand and other portable tools liable to be lost or stolen should not be included herein."

Most telephone companies maintain accurate inventories of the equipment falling under "General Tools and Implements, Account 265." Such inventories may be checked by the appraisal engineer—in sufficient detail as to verify their accuracy—with a comparatively small expenditure of time. This method—the method of spot-checking" the inventories—is recommended.

Materials and Supplies—Account 122

The instructions issued by the Interstate Commerce Commission state that: "This account should include the cost of unapplied material, including the value of material temporarily in use and not charged out in the company's accounts; articles in process of manufacture by the company; tools, fuel, stationery and other supplies. Freight and express charges paid on the material included in this account should be included in the value given of such material."

As in the case of "Tools and Implements," it will usually be found that the telephone company has a reasonably accurate inventory of the items falling under the classification "Materials and Supplies." This inventory may be checked in sufficient detail to assure the appraisal engineer of its accuracy—and then accepted, in toto, for use in the appraisement.

We have still to consider the inventory of the land and buildings. There is little to be said in connection with the inventory phase of these items—although we will have to consider them in detail, later, in connection with the appraisement.

The land should be described in sufficient detail to properly identify it. Usually such description may be obtained from the deed of purchase, and will take somewhat the following form:

Main Central Office.

Location—Southwest corner of Avenue A and First St.

Description—Lot No. 4, Block No. 14 and that portion of Lot No. 5, Block No. 14—lying to the westerly of the easterly boundary line of Lot No. 3—same being a part of "Blank Addition" to the city of Blank.

In connection with the inventory of the buildings, it may be well to quote the instructions of the Interstate Commerce Commission. These instructions follow:

"This account (Account 212, Buildings) should include the cost of all buildings, such as general and central offices, shops, stables, storehouses, etc. devoted to the general purposes of the company; also of all permanent fixtures, such as water, steam and gas pipes and fixtures; electric wiring and fixtures for lighting, signaling, etc.; elevators and engines and motors especially provided for operating them; furnaces, boilers and other apparatus provided for producing steam for such engines and for heating; electric generators especially provided for producing current for lighting such buildings, etc.

"This account includes such piers and other foundations for machinery and apparatus as are designed to be permanent in connection with the buildings with which they are constructed and to outlast the first machinery or apparatus mounted thereon. It also includes the cost of real estate brokers' commissions; examinations and registrations, etc., architects' fees —the cost of grading and special sidewalks, fences, etc., etc.

"This account does not include any telephone equipment, wiring or apparatus for generating, or controlling, electricity for operation of the telephone system."

In connection with the inventory of the buildings, it may be said that all buildings owned by the company should be considered. The location and present use should be designated. The location should be specified by the street number or address. Use may be for central office purposes; for storeroom purposes; for garage use or for miscellaneous purposes. The following is a typical inventory or listing of buildings:

Location—3959 Central Avenue.

Use—"Washington" Central Office.

Description — Fire-proof Building, brick bearing walls, partitions in basement brick, three stories and basement, designed for extension to rear and for fourth story, doors and windows in front, rear and north elevations wood, windows and doors in south elevation and east elevation in stair wing fire-proof, columns, girders and beams steel fire-proofed, floor and roof slab construction reinforced concrete, third story ceiling slab is future fourth floor finish floors and bases cement except in first story hall where bases are marble, cinder fill on third story ceiling slab for roof, composition roof on cinder concrete on cinder fill, doors leading to halls, fireproof, tin clad doors in casement, piped for gas, wired for electric light, complete plumbing and fixtures brick mantel, fire place, oak wainscot and paneled ceiling in operators' rest room on third floor, conduit system for telephone and signal wires, fire escape, lighting fixtures, Dunham Vapor heating system with Ideal sectional cast iron down draft boiler, switchboard platform, kitchen equipment, dry well.

Cubical contents 145,922 cubic feet.

In connection with the listing of the foregoing inventory, careful note should be made as to the condition of the building as a whole and of its component parts.

We have now completed our consideration of the subject of Inventories. It will be remembered that on each of the field forms—and in connection with all of the detailed instructions given—mention has been made as to the necessity of recording the "condition" of the portion of the plant under consideration. It was also previously suggested that the present condition is to be noted at the time of recording the inventory—in order to save inspecting the plant twice. However, to avoid confusion on the part of the reader, it was deemed advisable to postpone the discussion of ways and means of determining present condition until after the reader had thoroughly mastered the subject of depreciation. In the October installment the subject of "Theoretical Depreciation" will be discussed in detail and this discussion will be followed by suggestions as to ways and means of determining actual present condition as found in connection with the cataloging of the inventory data.

"I convinced myself that if we were spending 3 per cent for telephones (instead of 2 per cent) we would be just that much better off, for every telephone call represents time and steps and energy of valuable employes saved."

—John F. Gilchrist, V. P., Commonwealth Edison Co.

Practical Plant Problems

Chapter VI—The Fundamental Plan—Continued

By Charles W. McKay, Associate Editor

As suggested in the closing portion of the August installment, the last stage of the development study is in reality, the initial step of the work involved in preparing the fundamental plan. In Fig. 5, in the August installment, the central office location, the main feeder artery, the branch feeder routes and the locations of the distribution cables were indicated. Next comes the determination of the size of distribution cables, the sizes of feeder cables and the number of ducts to be installed in each conduit run.

Probably the simplest way to effect the solution of this phase of our problem is to reverse the order of procedure and start at the subscribers' premises. From the recapitulation of the house-count data—as illustrated in Fig. 4 of the August installment—we can determine for each block, or group of blocks, the present number of subscribers' lines; the number of subscribers' lines required to furnish service at the end of the five year period and the number of subscribers' lines required in connection with the ultimate development.

The **size** of **feeder cables** is largely dependent upon the **immediate requirements**—and the **requirements for the five year period**. The **sizes** of **distribution cables**, and the **sizes of conduit systems**, are largely dependent upon the **ultimate** requirements.

In laying out the fundamental plan, we will utilize the "unit map" method of procedure. The town will be divided into areas—each area including 20 or 30 blocks. A map will be made for each area—of an approximate scale of 400 ft. to the inch. Within the boundaries of each city block we will transcribe, from the development study, the present line requirements; the line requirements for the five year period and the line requirements for the ultimate period. Proposed feeder and distribution routes will also be transcribed from the development study upon each of the map sections.

The form of unit map to be used in connection with the fundamental plan is illustrated in Fig. 6. It will be noted that the pole locations are designated by the hollow circles. In this connection, it may be said that many companies adopt the practice of leaving construction details—such as the location of poles—to the foreman in charge of the work. The writer believes that this is a questionable practice, as it takes the plant engineer but little longer to designate the pole locations. The constructing foremen are primarily interested in so placing the poles that they will be out of the way of traffic and in so building the line as to make it strong and durable. The plant engineer, if he is worthy of the title, is perfectly competent to provide for good line construction, and, furthermore, by locating the poles on the working plans, he should be able to effect many economies in line and drop wire distribution—economies which might be entirely overlooked by the construction foreman.

The pole locations should be designated by the plant engineer, both on the working map (by showing property lines, etc.) and by driving stakes

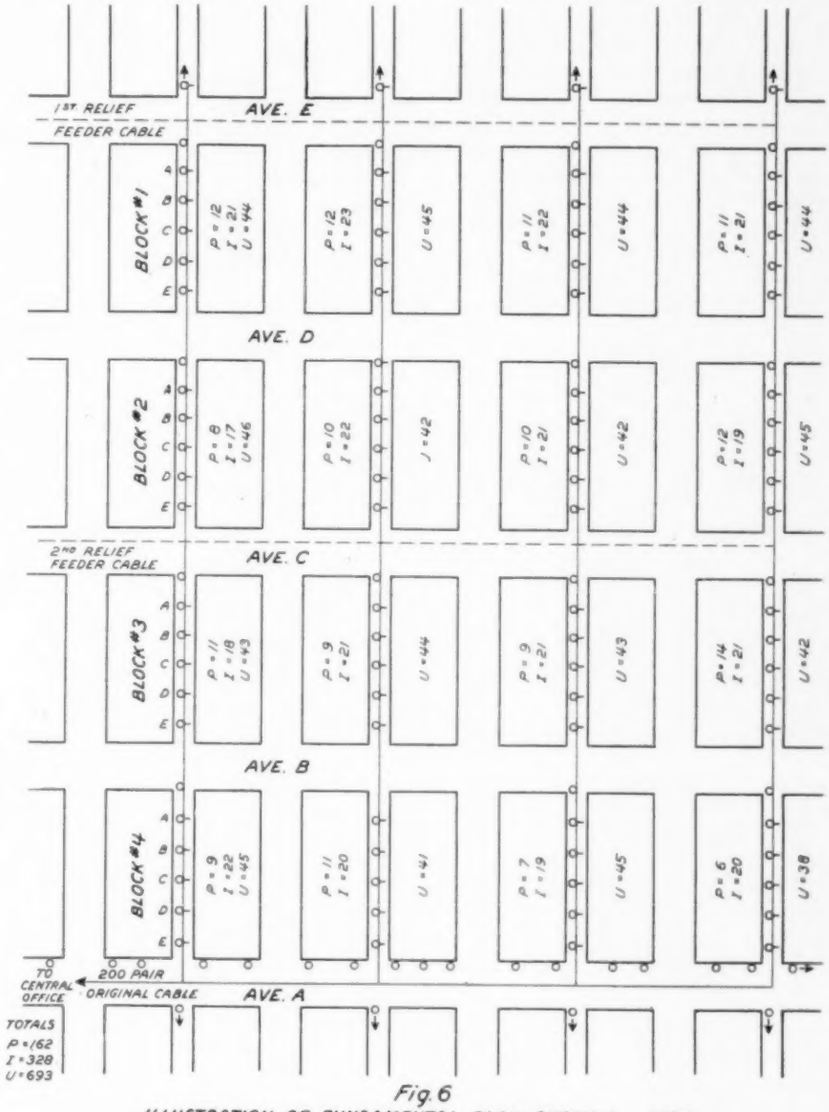

Fig. 6
ILLUSTRATION OF FUNDAMENTAL PLAN SECTION - MAP

at the actual pole locations. Other construction details—such as the location of anchors and guys—should also be specified by the plant engineer.

All of the foregoing data can be specified on the fundamental plan unit map—as illustrated in Fig. 6.

It will also be noted that in Fig. 6 the initial feeder cable has been shown by the heavy black line on Avenue A; the distribution cables by the heavy black lines on the north and south alleyways and the relief feeder cables by the dotted lines on Avenues E and C, respectively.

It will also be noted that the terminal locations have been indicated by the short, horizontal lines branching off of the distribution cables.

In each block, the line requirements for the immediate; five and ultimate periods have been indicated by the numerals preceding the symbols P (for present), I (for inntermediate, or five year, period) and U—for ultimate period.

At this point it may be well to caution the reader against confusing the blocks with the half blocks—as formed by the vertically bisecting alleyways.

Analyzing each block in detail, we find that in no case does the ultimate number of lines exceed 50 pairs of wires. This fact is significant in that it determines the size of the distribution cables—they will be be cables of 50 pair capacity.

It will also be noted that the total present line requirements for each vertical tier of blocks does not exceed 50 pairs. Hence, for the time being, one 50 pair cable can be placed in each alleyway—spliced to the feeder cable on Avenue A.

The line requirements at the end of the five year period, however, are sufficient to necessitate a 50 pair cable in each vertical pair of blocks. At this time—at or about the end of the five year period—a relief feeder cable will be extended on Avenue E and the vertical distribution cables, for each pair of blocks, cut and capped at, or near Avenue C.

To make the foregoing clearer to the reader, let us consider the left hand tier of blocks, numbered 1, 2, 3 and 4 respectively. The total present line requirement is 40 pairs; and we may therefore feed these four blocks for the time being by a 50 pair cable, spliced to the feeder cable on Avenue A. At the end of the five year period, however, we find that the line requirements for blocks 1 and 2 have increased to 40 pairs and the line requirements for blocks 3 and 4 to 38 pairs—hence, a 50 pair cable will be required for blocks 1 and 2 and another 50 pair cable for blocks 3 and 4. The relief is effected by extending an additional feeder cable on Avenue E and cutting and capping the distribution cable at or near Avenue C. We then have one 50 pair cable serving blocks 1 and 2 through Avenue E, and another 50 pair cable serving blocks 3 and 4 through the feeder cable on Avenue A.

Again referring to our line requirements, we find that some time between the end of the five year period and the ultimate period, between 40 and 50 pairs of wires will be required to supply each of the four blocks. The necessary relief is afforded by extending another feeder cable along Avenue C and cutting the distribution cables at Avenues D and B respectively. Eventually then, we will have a 50 pair cable for each block—Block No. 1 being served by a 50 pair distribution cable spliced to the feeder cable on Avenue E; Block No. 2 being cared for by a 50 pair distribution cable spliced to the feeder cable on Avenue C; Block No. 3 is served by a 50 pair distribution cable spliced to the feeder cable on Avenue C and Block No. 4 has an individual 50 pair distribution cable spliced directly to the feeder cable on Avenue A.

In order to accomplish this method of distribution, and relief, it is obviously necessary to terminate the entire 50 pairs in each block. Otherwise, it would be necessary to transfer terminals in order to obtain relief. Fig. 7 illustrates the method of splicing terminals to the distribution cables. Let us again consider the end tier of blocks (blocks 1, 2, 3 and 4 respectively). At the time the cable is originally installed, pairs 1-10 inclusive; 8-22 inclusive; 21-30 inclusive; 28-42 inclusive and 21 to 50 inclusive are terminated in the terminals a, b, c. d and e respectively in Block No. 1.

Now let us consider Block No. 2. We again terminate the same 50 pairs, but vary the terminal assignments—and the size of the terminals—so that the allocation of pairs will not be exactly the same as in Block 1. Terminal a, for instance, takes pairs 1-15; terminal b, pairs 13-22; terminal c, pairs 19-33; terminal d, pairs 30-39 and terminal e, pairs 36-50.

In the case under discussion, the pair assignment in Block No. 3 is exactly similar to that in Block No. 2—while the assignment in Block No. 4 corresponds very closely to the assignment in Block No. 1.

If the reader will review, carefully, Figs. 6 and 7, he will have no difficulty in understanding that when the first relief feeder cable is installed on Avenue E, it is only necessary to cut and cap the distribution cables at Avenue C—in order to have a 50 pair cable available for blocks 1 and 2, and another 50 pair cable available for blocks 3 and 4—without making any changes in the terminal assignments. By the same reasoning, the cables may be again cut and capped at Avenues D and B respectively (at the time the relief cable on Avenue C is installed), and the entire 50 pairs will be available in each of the blocks 1, 2, 3 and 4.

Referring to Fig. 7, the reader will note that, in each of the blocks, terminals a and b have certain pairs in common—and the same is true for the other terminals. This, in telephone parlance, is known as "bridging" pairs—and it is an excellent plan where party line service is to be provided. The writer has already called attention to the fact that party line subscribers are apt to be scattered during the initial periods of telephone development—while later, toward the end of the ultimate period, the telephone development will have become so dense that it is possible to concentrate party line subscribers.

To illustrate, let us assume that, at the time the system depicted in Figs. 6 and 7 is installed, there is a demand for four party service near the northerly end of blocks 1, 3 and 4 respectively. Obviously, these party line subscribers can all be assigned to the same cable pair—but in different terminals. We may assume that they are assigned to pair 2 in the northerly terminals in blocks 1, 3 and 4 respectively. Later on, of course, blocks 3 and 4 will be separated from 1 and 2—at the time the relief feeder cable is provided on Avenue E. However, by that time there will probably be enough more four party subscribers so that the subscribers which are connected to pair 2 in blocks 3 and 4 may be assigned to some other telephone number—and other four party subscribers placed on the same pair. Also, in blocks 1 and 2, party lines can probably be so concentrated that three or four subscribers will be assigned to pair 2 of the 50 pair cable connected to the original feeder cable on Avenue A. It is also true that the common, or "bridged" pairs between terminals a and b, etc., are a great help in making two party line assignments—either at the time of the initial installation, or later.

Aerial Feeder Cables

We have now completed our consideration of the subject of aerial distribution cables, and the next logical step is the determination of the size

of the feeder cables. First, we must determine the sizes of the initial feeder cable on Avenue A—and then it is probable that the same sized units will be used for the relief feeder cables on Avenues E and C respectively.

Before taking up a detailed consideration of the case in hand, however, it may be well to pause for a moment and consider the general subject of feeder cables—and the factors to be considered in determining whether feeder cables shall be placed aerially, or in underground conduits. These factors are:—

1. The number of pairs required for feeder facilities at the time of the initial installation.

2. The subscribers' requirements—in terms of lines or pairs—at the end of the five year period and the rate at which the expected increase will take place.

3. The number of lines that will be required for the ultimate period.

4. Another factor which must be considered most carefully—in connection with the problem of deciding whether feeder facilities should be of the aerial or underground type—is the size of cables that may be carried safely on a pole line of average size and strength. At this juncture, it may be said that pole lines may be so constructed as to carry 600 pair cables. A 600 pair cable, however, is very unsightly—and, unless the case under consideration is an unusual one, we may safely limit the size of aerial feeder cables to 400 pair capacity.

In deciding whether a given cable shall be placed aerially or underground—all of these factors must be carefully considered. Furthermore, first costs and annual charges (for both the aerial and underground feeder cable type of plant) must be carefully compared before a final decision is reached.

Returning to the case under consideration—that illustrated in Fig. 6—it will be noted that the line requirements for the initial, five year and ultimate periods have been summarized. The grand totals are given at the left hand margin of the figure.

We find that 162 lines are required to give immediate service; 328 lines for the five year period and 693 lines to meet the ultimate requirements.

As previously suggested, the size of feeder cables is largely determined from a consideration of the initial and five year period requirements. The total initial requirements are 162 lines, and the requirements at the end of the five year period, 328 lines. Expressed in terms of feeder cable pairs—the foregoing figures would seem to indicate that a 200 pair cable will be required to give immediate service, and that a 400 pair cable will be required by the end of the five year period. In considering this phase of our problem, we must not overlook the fact that we are planning relief feeder cables on Avenue E and C respectively. In view of this latter fact, it is thought that a 200 pair aerial feeder cable should be installed on Avenue A—despite the fact that the five year requirements indicate that a 400 pair cable will be needed. This for the reason that relief is planned on Avenue E and C respectively.

Our fundamental plan, therefore, will provide for the installation of an initial 200 pair feeder cable on Avenue A, and the relief of this feeder cable at, or near, the end of the five year period by an additional 200 pair aerial feeder cable on Avenue E. Eventually, these cables will be further relieved by another 200 pair aerial cable on Avenue C, and, probably, by a 200 pair aerial feeder cable on the second street south of Avenue A (not shown on the map, illustrated in Fig. 6).

It is thought that the foregoing will give the reader a general idea of the method of determining feeder cable sizes. We trace the pair requirements (for the initial; five year and ultimate periods) back toward the central office—always taking into consideration the future aerial relief provided on parallel streets—such as Avenues E and C. Knowing the requirements for the various periods and the ultimate size of feeder cable which may be wisely provided for aerially—we can determine which feeder cables should be of the aerial type and which of the underground type—and the various pair capacities of each cable.

In the October installment, we will continue our consideration of the feeder cable problem—tracing the feeder cables back toward the central office.

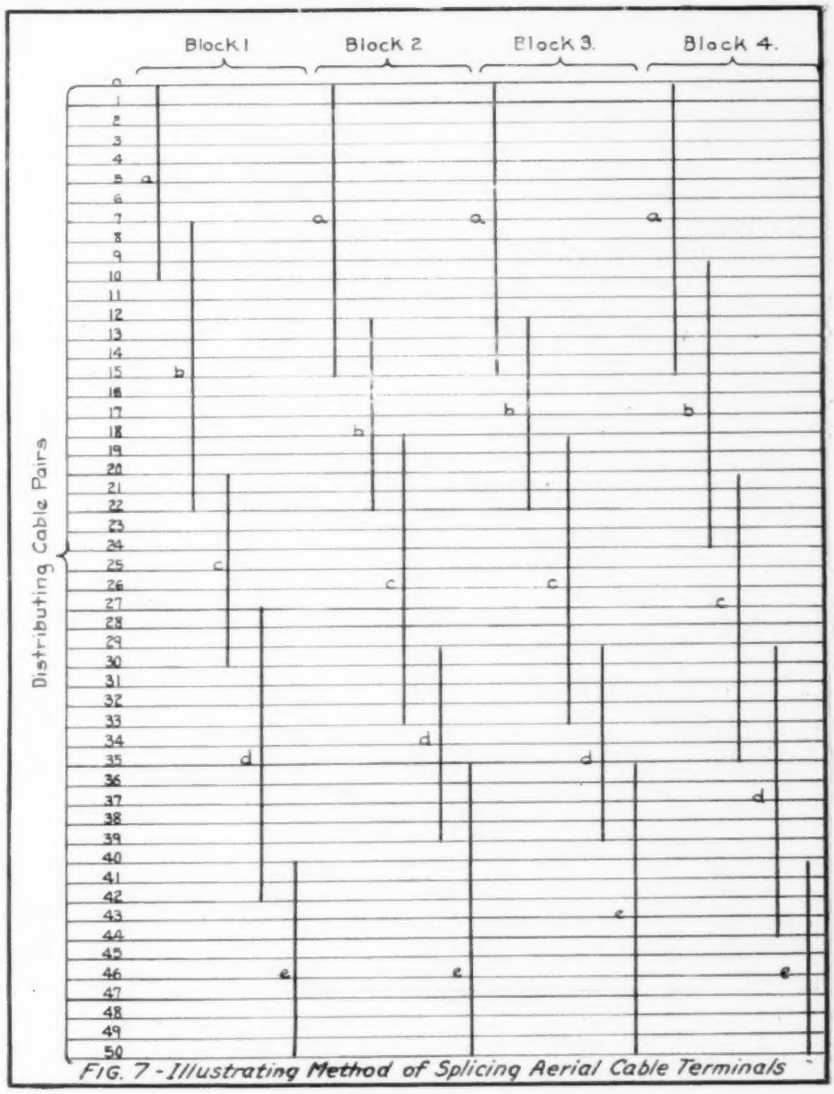

FIG. 7 - Illustrating Method of Splicing Aerial Cable Terminals

District Groups to Step Some in September

Chicago, Ill.—Reports from the Minnesota, Oklahoma and Up-State New York telephone associations indicate that September will be a busy month for these organizations. Beginning September 11 the Minnesota association conducts ten meetings in various points in the state. The same general program, consisting of talks on local and long distance operating, operators' schools, public relation address, plant construction and maintenance, inductive interference, transmission losses, accounting and other telephone problems, will be given at each meeting.

The Ninth and Tenth districts of New York's Up-State association unite for a meeting at Jamestown, September 14 and 15. John H. Wright, vice-president of the Ninth district, and Fred C. Saunders, vice-president of the Tenth district, will officiate. Oklahoma's Seventh District meets in Clinton, Sept. 12, with J. A. Wright of Carnegie, chairman of the district, at the helm. A feature of the meeting will be an address by Campbell Russell, Chairman of the Oklahoma commission.

VAIL AWARDS MADE

Distinguished Service of Bell Heroes and Heroines Earns Official Recognition

Chicago, Ill.—During the past several weeks awards of Vail medals, in accord with the terms of the will of the late president of the American Telephone and Telegraph Co., have been made to employees who conspicuously distinguished themselves beyond the usual requirements of public service.

Newspapers throughout the country have covered the awards, and the impressive ceremonies attend upon distribution of the medals.

June Phone Incomes Increase $3,633,928

Washington, D. C.—Seventy telephone companies for June, 1922 as reported to the Interstate Commerce Commission, showed operating revenues amounting to $49,392,362, an increase of $3,633,928 as compared with the operations of the same companies in June, 1921. Balance after expenses, stood at $14,736,556, an increase of $1,689,068 over a year ago, while operating income was $10,836,605, an increase of $1,253,069. For the first six months of the year total operating income was shown at $286,969,196, an increase of $21,254,491 as compared with the first half year of 1921. Balance after expenses was $85,003,207, an increase of $11,549,294 as compared with the first six months a year ago, and operating income stood at $61,966,827, an increase of $7,558,469 as against the half year of 1921.

Prepare to Loosen Your Belt At Illinois Association Feast

Peoria, Ill.—The Jefferson Hotel, at which the annual meeting of the Illinois Telephone Association meeting is to be held, Oct. 4-6, has ordered 600 guinea hens for the association's annual banquet.

Wampler Resigns from Indiana Bell; Rottger Assumes Job

Indianapolis, Ind.—Frank Wampler, for 25 years associated with the interests now known as the Indiana Bell, has resigned as Vice-President and General Manager. His new connection has not been announced. With Mr. Wampler's resignation, the office of general manager was abolished, and C. H. Rottger, president of the company, has assumed the position of active manager.

Illinois Bell Vail Medal Winners Receive Awards from President W. R. Abbott
From Left to Right: Miss Mary Craig, N. R. Harrison, Herman H. Krueger, Frank O'Connor, Grover A. Peterson, President W. R. Abbott of the Illinois Bell, John Ribicki, James E. Richardson, John Reiman, George W. Stoltz, Arthur I. Whiteman

WORLD PHONE SCHOOL

New Western Electric Magazine to Inform Foreigners of Communication Progress

New York City—Publication of a house organ destined to fill an important place in the telephone industrial education of government telephone officials, educators, and others intimately connected with telephone work in foreign lands, has been instituted by the information division of the Western Electric Co.

The new publication, known as "Electrical Communication", first appeared in August. Its sub-title, "A record of progress in the telephone, telegraph and radio art", outlines its scope.

Articles in the initial number are exceedingly interesting and valuable. They set a standard that should win quick favor and build up a good mailing list. Featured in the opening issue are: "Recent Developments in Electrical Communication", by J. L. McQuarrie, "Description and Operation of Telephone Repeaters", by Bancroft Gherardi, "The Dynamical Theory of Amplifying and Oscillating Systems", by H. W. Nichols, "A New Type of High Power Vacuum Tube", by W. Wilson, "Some Notes on Statistics", by S. L. Andrews, "Rehabilitation of Antwerp Factory", by J. S. Wright, "Analysis of the Energy Distribution in Speech", by I. B. Crandall and D. MacKenzie, and "The Nature of Speech and Its Interpretation", by Harvey Fletcher.

"Money Back" Meeting Again Is Staged by Illini

Decatur, Ill.—One of those Illinois district meetings that can make a guarantee of "1000 per cent profit or money back" to all those investing time and money in attendance, was held by the Illinois state association here August 29. Addresses included "Toll Revenues in Small Exchanges" by J. C. Poole of Lincoln, and "Development of the Short Haul Telephone Plant", by F. A. Norris of Monmouth. In the traffic conference and operators' school, another performance of Vivian's "greatest show on earth" was given. The meeting was held in conjunction with the session of the Central Illinois association, and many prominent telephone men attended. Dr. R. E. Gordon, President of the state association, and Jay Mitchell, its secretary-treasurer, made feature addresses.

G R Pole Cable Terminals

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Protects
Cable Stub

Maple Panels
No Sweating
No Leakage

Reliable Electric Company

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Trouble Location in Buried Cable

One of our readers asks if we know of any instrument for locating trouble in cable buried two feet below the surface of the ground. We, of course, could tell him about the Wheatstone Bridge and the various testing sets operating on the Wheatstone Bridge principle. We could also tell him about some of the various "wireless" or exploring coil testing outfits which would require the digging of test pits at various points along the cable that is in trouble, but which do not operate very successfully when used along the surface. We have heard of the use of a coil of twisted pair drop wire which was loaded into a wheelbarrow and a low resistance receiver connected to the two ends. The coil was then wheeled along the cable until the fault was discovered in the usual way when the tone disappeared. Perhaps some of our friends who have been using cable buried in the earth without conduit have developed other methods or can give us their experience with the one that we have suggested.

Adds Breathing Machine to First Aid Equipment

Athens, Ohio: The Athens County Home Telephone Company has purchased two breathing machines for producing artificial respiration in cases of asphyxia, electric shock, drowning, mine accidents and the like. These machines have been installed where they will be subject to instant call night or day. "The Lyon Breathing Machine," as the device is called, is a two cylinder, self-contained apparatus. On the upward stroke air is drawn from the atmosphere into the upper chamber; at the same time foul air is withdrawn from the lungs into the lower cylinder. Upon the downward stroke, the pure air in the upper cylinder is impelled from the tube and face mask to the lungs and the foul air in the lower cylinder is exhausted into the atmosphere. An oxygen connection is provided so that oxygen may be administered if necessary.

Central office reproduction cost for the New York Telephone Co. in New York is $79,761,300.

Impressive Volume Registers Metric Standard Interest

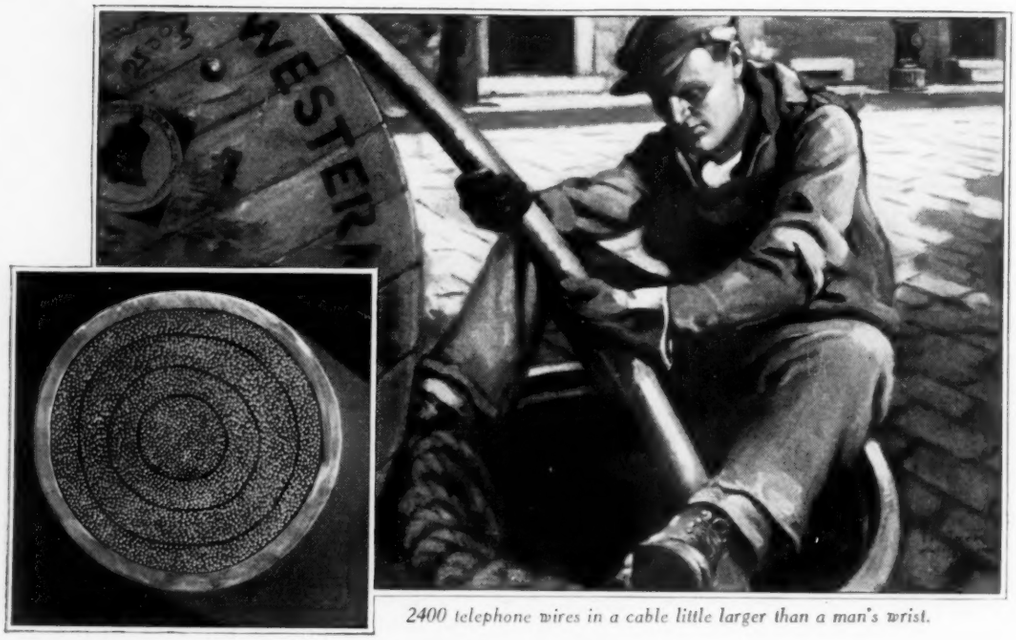
San Francisco, Cal.—"World Metric Standardization, an Urgent Issue," has been issued by the World Metric Standardization Council. It is a large volume of theory and fact on the employment of metric standards, and is of particularly timely interest to American manufacturers concerned with export trade.

2,498,493 Phones on Farms According to Census

Washington, D. C.—1920 census figures recently released put the number of farm telephones at 2,498,493. Rentals at that period totalled $13,411,379. Of the farms reporting to the census bureau, 38% were equipped with telephone service in 1920.

Trans-Atlantic Radio Service Before End of 1922?

New York City.—Speaking at a dinner given in honor of Senator Marconi, E. J. Nally, President of the Radio Corporation of America, indicated that radio telephone service between New York, London, and Paris, might be available by the end of the year.



2400 telephone wires in a cable little larger than a man's wrist.

Science keeps down costs

When the Bell System installed its first successful telephone cable, fifty wires was the largest number that could be operated in a single cable without "cross-talk" and other interference. Today it would require 48 cables of the original type to accommodate the number of wires often operated in one cable.

Without this improvement in cable, the construction of new underground and aerial lines would have cost the Bell System upwards of a hundred million dollars more than has actually been spent. In addition, the cost of maintenance would have been greater by eighteen million dollars a year. These economies in the Bell System mean a saving in telephone rates to each individual subscriber.

In all branches of telephone practice science has similarly contributed to economy. Even in such a comparatively small item as switchboard cords, improvements have reduced the cost of renewal by four million dollars a year.

Every new telephone added to the Bell System increases the usefulness of *all* telephones, but this multiplication tends likewise to increase the complications and the expense of service. The scientists of the Bell System, to offset this tendency, are constantly called upon to develop new devices which simplify complications and keep down costs.

By virtue of a united system the benefits of these improvements are shared by all subscribers—and the nation is provided with the best and cheapest telephone service in the world.

"BELL SYSTEM"

AMERICAN TELEPHONE AND TELEGRAPH COMPANY

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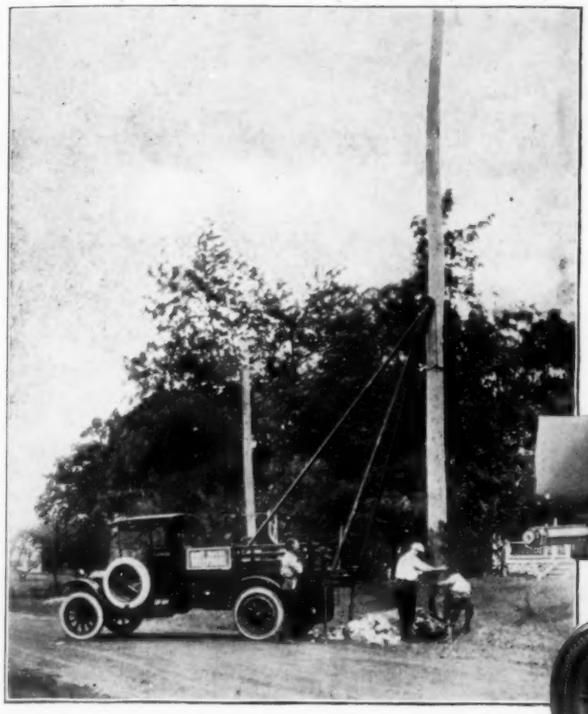
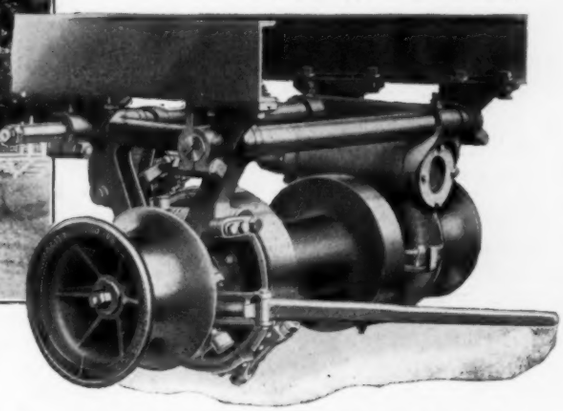


POLE-SETTING

—the quickest and best way



The Mead-Morrison Underslung Winch saves time and man-power in pole-setting work

POLE-SETTING with pike poles is necessarily slow and tedious, and involves 8 to 10 men. Three men can set poles of any size with a Mead-Morrison Winch and derrick arrangement.

The Underslung Winch-equipped truck illustrated here on a pole-setting job at Lawrence, Mass., shows the most modern method.

A feature of this Winch as regards pole-setting work is the fact that it may be arranged for side control (see photo), giving more space and freedom at the rear of the truck.

Our nearest agent can give you full details regarding Mead-Morrison Winches for this and other types of work.

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Texas Motor Truck Equipment Co., Dallas, Texas
The Salt Lake Hardware Co., Salt Lake City, Utah
The Truck Engineering Co., Cleveland, Ohio
Truck Equipment Co., Inc., Buffalo, N. Y.
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MEAD-MORRISON WINCHES *for pole-setting and cable-hauling*

"Listening In" on Foreign Lines

TONGA'S TALKING WIRE

South Sea Isle System Presents Installation Problems—Life Soft for Natives Here

Wellington, N. Z.—Representatives of the International Western Electric Co. have installed a telephone system of less than a hundred subscriber lines, most of them on the main island of the 303 comprising the Tonga group in the South Sea.

Unusual difficulties beset the engineers sent to Tonga to install the system. Most of the islands lie so low in the water that it was almost impossible to dig holes for the telephone poles. On the main island, which is nothing but coral formation six feet above sea level, it was necessary to brace up each pole with especially prepared blocks and to give each of them an extra coat of tar as a protection against the elements. As the cocoanut trees which form the only wood supply of the island are not strong enough to bear any additional burdens, all the poles used for the lines were imported from New Zealand.

It proved almost impossible to get any unskilled labor for the less important phases of the project. In fact the native males have such a natural antipathy to work of any sort that it was necessary for the Tongan government to supply a gang of ten prisoners from the local jail and an interpreter to aid the Western Electric representatives.

Another condition that handicapped the completion of the job was the scarcity of horses in Nakualofa, the Tongan metropolis. The problem was finally overcome when the engineers and their government friends commandeered a handcart which, after being considerably strengthened, served as the sole means of transporting all over the kingdom the heavy equipment used in the system. Anglo-Saxon ingenuity also came in handy in devising special tools for the native workmen, who, because of their lack of footwear, were unable to manipulate the usual type of long shovels used in pole-hole digging.

In their report on the completion of the Tonga telephone system the engineers attribute most of the difficulties which they met in their attempt to advance the cause of civilization in the islands to the Utopian occupations of the natives. Practically all of the time in Tonga is spent in church going, bettle hunting, attendance at movie shows, swimming and eating. In between whiles when they happen to think of it, the more ambitious of the Tongas do some work on the cocoanut plantations.

FOREIGN PHONE WORK

U. S. Government Report Gives Features of Activities Abroad

Washington, D. C.—The U. S. Department of Commerce in a recent bulletin tells of radio progress in Japan and Argentina and of the new telephone cable between England and Holland.

The Department's circular says: Telephone communication by radio will be opened across the Chosen Strait in the early part of this month. The stations at Fukuoka and Fusan contain the necessary equipment and it is expected that the shipping along the coasts of Kiushu and Chosen will take advantage of this service. This particular installation is a unit in the Japanese government plan for linking up the various islands of the Empire by wireless telephone and telegraph.

According to Commerical Attache Feely, no laws have yet been passed to govern wireless telephony in Argentina, but a bill is being drafted for presentation to the next Congress to regulate the use of radio sets. No regulations at the present time in effect prevent the sale of broadcasting and receiving sets. The latter are being manufactured to some extent locally, but of very inferior quality and sell at from 200 to 700 pesos.

Telephonic communication has been established between England and The Netherlands, the result of the completion of an ocean telephone cable extending from Aldeboro, England, to Domburg, on the Dutch coast. From Domburg the trunk lines will form a connection through the Middleburg exchange with the long distance lines of Holland.

Mexican State to Have System in Six Months

Tampico, Mexico.—Application has been made for a concession to construct a telephone exchange and system here and to build a system of long-distance lines in the State of Tamaulipas. At least 3500 telephones are to be ready for use within six months.

Much New Construction in Briltish Columbia

Vancouver, B. C.—Telephone Talk, the live magazine published by the British Columbia Telephone Co., gives details of the extensive construction program that is being carried out this year in that Canadian Province. Two thousand two hundred feet of 800 pair cable and 1,200 feet of 600 pair, as well as several thousand feet of smaller sizes will be placed in the Nanaimo district. A long cable to replace an open wire lead is being constructed in the Milner district. In Vancouver a composite cable of 16 ga. 19 ga. and 22 ga. conductors is being placed from Seymour to Higland and Fairmont offices and estimates are under way to provide additional facilities in the West End, East Point Grey and West Vancouver districts. Over 20 miles of fir conduit is being manufactured for use in the underground construction projected for the year. A new power plant is to be installed in Seymour office and also a tandem switchboard to speed up the two number service between offices of the area which do not have direct trunks. Additional switchboard facilities are being installed in Vancouver toll, Fairmont, Bayview, Highland, North Vancouver, Victoria and Nanaimo offices.

British System in Uruguay Sold—Raw Deal Claimed

Montevideo, Uruguay.—An agreement has been entered into for the purchase by the State of Uruguay Telephone Co., which is an English joint stock concern, and the oldest, and by far the largest, of the two telephone companies operating in Montevideo. The purchase price is $700,000. For the present the "Uruguay" will be worked by the Western Electric Co. until the State subterranean system, for which the latter holds the contract, has been constructed, when the older company will be absorbed. The Electrical Review of London, in commenting on the sale, regrets the disappearance of a British enterprise that, with all its faults, has done good service in its time, and was the pioneer in introducing the telephone in Uruguay. Welcomed at first, of late years it has not received fair treatment at the hands of the Government, says the English paper, which claims for unfair treatment of foreign enterprises which stand in the way of Government plans

Always the Same Dependable Quality

Whether it's the first one out of the barrel or the last, French Telephone Batteries are always uniform. They give full rated power when in use, and during idle periods internal action is cut to a minimum by our special coating which protects the zinc against the active chemicals.

You can count on French Uniformity to cut down your battery costs and improve your service. High capacity and long life in active use, and long shelf life are characteristic of all French Telephone Batteries. That is why they are universally used.

Send for a trial barrel of our No. 6 French Telephone Batteries and run a careful test. The results will show you why many companies have already standardized on French.

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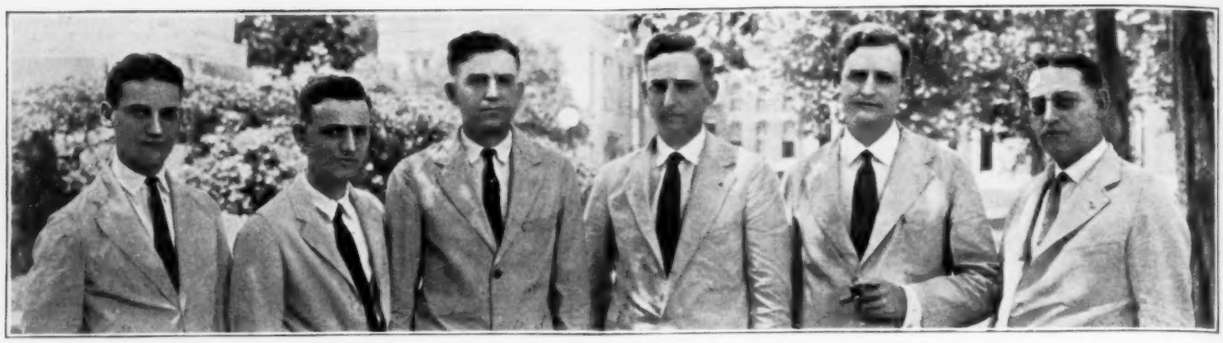

Here are the six Baird brothers, all of whom are employed by the Cumberland Telephone and Telegraph Company. They are native Louisianians, and have "stuck" to their old home state. They are all employed by the company in Louisiana. Three of them hold important executive positions, while the other three are "learning the ropes" now. From left to right they are: W. R. Baird, the youngest, three years in New Orleans office; J. K. Baird, formerly of signal corps 39th Army Division, now in New Orleans; Vernon K. Baird, 18 years in the service, now district manager of Lake Charles district; T. Barton Baird, 20½ years' service, for several years district manager of New Orleans district; Andrew P. Baird, 18½ years' service, district manager of Alexandria district.

The Bairds — A Phone Family

New Orleans, La.—What is said to be a record for one family's service in a single corporation, has been achieved by the six Baird brothers who are connected with the Cumberland Telephone and Telegraph Co.

Starting with T. Barton, manager of the Cumberland's New Orleans division and going down the line to W. R. Baird, the "kid" of the clan, the Baird boys are devoting themselves to Cumberland service.

The Times-Picayune, of New Orleans, recently commented upon the Baird family's unanimous endorsement of the Cumberland as a company worth working for, saying in its columns:

"Seldom it is one finds an entire family following the profession. Not infrequently two or even three brothers form a partnership, but when six brothers choose the same profession, cast their lots in their native state and all win success in the same profession it is odd.

"Almost twenty-one years ago T. Barton Baird, now manager of the New Orleans district of the Cumberland Telephone and Telegraph Company, chose as his profession the field offered by the then comparatively young industry. It was a promising field, so he forsook the study of law and became a night telegraph operator. Through successive stages he served, finally attaining his present position. Today his five brothers are employed by the same company. Two have met with the same degree of success. Three — the younger — are learning the ropes and following in their brothers footsteps.

"It happened because T. Barton Baird had a taste for mechanics and things electrical. He had decided on law as a profession and was pursuing his studies at Centenary College, Jackson, La., while working as a night telegraph operator. He chose the latter and upon graduation entered the employ of the Cumberland Company. He soon persuaded his oldest brother, Andrew, to join him, and as the four younger brothers were graduated they were induced to do likewise.

"Barton and Andrew Baird are now executives in the company. Barton is in charge of the New Orleans district and Andrew of the Alexandria district. Another brother, Vernon A., is district manager of the Lake Charles district.

"Setting poles, splicing cables, fixing connections are things quite familiar to the three older brothers. They have all done it. Back in 1915 following the hurricane of that fall T. Barton Baird got down in the main below the street levels and spliced cables with his own hands. Phone patrons didn't know it, but Mr. Baird did it nevertheless.

"The three younger brothers, W. B. Baird, W. H. Baird and J. K. Baird, have been with the company for several years. They are going through the same mill—although much more modernized — that turned out their older brothers.

"When the older brothers entered the service methods of communication were crude compared to present-day efficiency. They have seen the old type of switchboard go and with it the old-fashioned crank used by patrons to signal the operator. The younger brothers have begun in a modernized era and will help write the future history of the telephone industry.

Peerless Automatic Water Stills Interest Many Industries.

South Bend, Ind.—The Sparta Manufacturing Co., 111 S. Hill St., is selling many of its Peerless Water Stills in the various industries where pure water is required such as the gas, oil, electric and automotive fields. The telephone field also uses many for its batteries and to furnish the operators and other employees with exceptional drinking water.

One operation of the Peerless Still, Pres. R. C. Singler says, makes the worst water absolutely pure and perfect for all refining purposes, for batteries, medical, chemical and drinking purposes. The cost ranges from one to two cents per gallon for gas, when gas sells for $1.00 per 1000 cu. ft.

Model E still, shown herewith expells all sulphur, ammonia and other impurities.

Model L electrical still may be operated at about the same expense as an ordinary flat iron which is from four to five amperes per hour, at 110 volts, the production being from two to three quarts of water and costing about two to three cents per hour to operate. This still also may be operated by gas, if desired.

The price of Model E is $35 and of Model L electric $40. Either may be had with steamer attached for battery stations for $10 extra.

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THEY DO NOT RUST AWAY

Ideal for All Earth Grounding

NO RUSTING—because of the thick welded copper exterior.
NO BENDING—the stiff steel core prevents bending.
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Bonita Aerial Cable Rings are attached in a jiffy by hand. They are standardized, specified, approved or used by most of the leading telephone companies because of their efficiency.

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Easy to pull in
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TELEPHONE AND TELEGRAPH WIRE

PROVEN BEST BY TEST

Time and the aid of America's foremost engineers, have enabled us to develop and manufacture the highest grade wire known to the trade. It is greatest in conductivity and lasting qualities, due to the superior quality of material from which it is made, as well as its *Extra Double Galvanizing*, which insures longest life.

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Single and Double Galvanized, Standard, Siemens-Martin, High Strength and Extra High Strength Grades.

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INDIANA STEEL & WIRE CO.
MUNCIE, INDIANA

Experts Form Phone Directory Publishing Company

New Castle, Pa.—With Carl L. Leathers as General Manager, the Garle Directory Co. has been formed here, for the purpose of publishing and editing telephone directories. One of the features of the business will be the promotion of co-operative work among the smaller telephone companies, so that directories may be combined and toll business encouraged. Associated with the Garle Directory Co. is the Garle Operating Co. for selling directory advertising and soliciting new subscribers for telephone service. One of the achievements of the organization which is in process of completion is a directory which is said to embody many novel features of great value to the telephone company and its patrons. Offices of the Garle Directory Co. are in the Wyrie Bldg., New Castle.

Incorporate to Run Rural Line on Little Rock Highway

Little Rock, Ark.—The Suburban Telephone Company of Little Rock has filed articles of incorporation. The incorporators are M. L. Sachs, president; D. K. Hawthorne, secretary and treasurer and C. C. Lovejoy. The capital stock is $50,000, of which $300 has been subscribed. The company proposes to erect approximately 15 miles of rural telephone lines along the Little Rock-Hot Springs highway, the upper Hot Springs road and the Mabelvale pike.

Newspaper Suggests Phone Ad Selling Idea

New York City.—Editor and Publisher, a business journal of newspaper interests suggests to local newspaper advertising men that "A telephone page in hot weather is especially easy to sell. Sell the manager of your telephone company a commanding space at top of page for any message he may like to impress upon the public. Then sell the other spaces to merchants who deliver goods. Each ad should call attention to a special service or bargain which can be ordered by telephone."

Wilder Succeeds Stevens As Tri-State Official

St. Paul, Minn.—R. F. Wilder, a thoroughly trained telephone man of twenty years' experience, has succeeded Rollo R. Stevens as General Commercial Superintendent of the Tri-State Telephone and Telegraph Co. For the last twelve years Mr. Wilder has been with the Tri-State.

Kellogg's Cuties

—Photo International

The camera man boasts he has a keen eye for class and presents this view at the Kellogg booth at Chicago's Pageant of Progress to support his claim. Far be it from us to argue with the lens lad. The Kellogg display, he says, quoting the two lovely little flappers shown with the Kellogg instrument, was "quite the bee's knees."

PIONEERS AT CLEVELAND

Bell Veterans Plan Biggest Meeting, September 29-30 — Demonstrations Slated

Cleveland, O.—A number of special trains will bring the greatest number of delegates that ever attended a convention of the Telephone Pioneers of America, to the society's annual meeting at Cleveland, September 29-30.

Special demonstrations under the auspices of the Bell will be held in Cleveland's new seven million dollar public hall. Hotel Cleveland has been named as convention headquarters.

The Pioneers and their families will attend an outing at the Cleveland Yacht Club as guests of the Western Electric Co. Other entertainment features including a notable banquet, are on the boards.

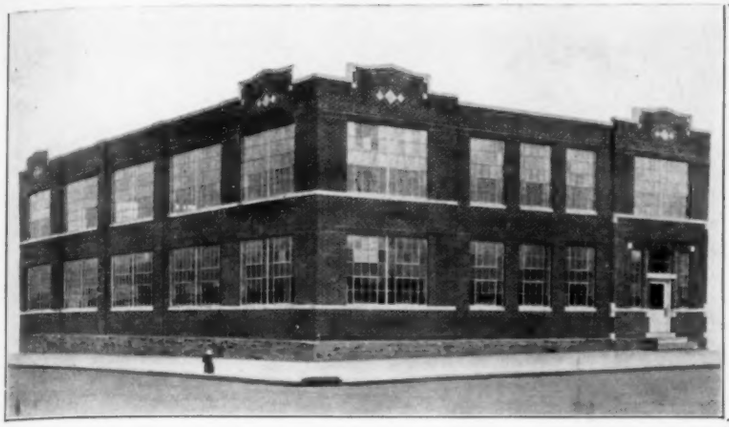
Many of the Bell tribe are planning to attend the Pioneers' meeting as a stop on their vacation trips. R. H. Starrett, Sec. of the Telephone Pioneers of America, 195 Broadway, New York, will supply interested parties with additional information.

Bureau of Standards Guides to Radio Information

Washington, D. C.—Many persons who have become interested in radio telephony during recent months have not been familiar with the various sources of information on the subject. To supply such persons with the sources of information, the Bureau of Standards has issued a Letter Circular, known as LC 39, "List of Sources of Elementary Radio Information." The circular not only points the way toward securing information on radio subjects but itself contains a considerable amount of information. It contains a list of periodicals ranging from the popular magazines to the very technical publications of the Institute of Radio Engineers and the Radio Review of London, England. The list of government publications on radio may be secured by writing the Superintendent of Documents, Government Printing Office, and asking for "Price List No. 64," which will be sent without charge. The Bureau of Standards has published a number of papers which are listed in Bureau of Standards Letter Circular No. 40. It has also prepared an elementary text book, "The Principles Underlying Radio Communication," published as Signal Corps Radio Communication Pamphlet No. 40, a copy of the 1922 edition of which may be secured for $1.00 from the Superintendent of Documents. The Letter Circular also gives a list of radio books classified into three divisions, books suitable for beginners, elementary text books and advanced texts for reference. A brief summary of American and Canadian radio laws and a description of the method of assigning station calls are given.

New Bell Issue of 115 Million Offered

New York City.—The American Telephone and Telegraph Co. offer stockholders of record on Sept. 8, one share of new stock at par for each five shares outstanding for a total amount of $115,000,000. In making the announcement, President Thayer said: "In the last two years of adverse business conditions the demand for telephone service has shown no abatement. In that period there have been 1,000,000 telephones added to the Bell system, and there are now on file unfilled applications for about 200,000 telephones." The company is said to have cash enough on hand to take care of approaching maturities amounting to some $35,000,000, so the proceeds of the new stock issue can be devoted to improvements.



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Indicating Rail Bond Testers—Ohmmeters, Test Sets, Galvanometers, Etc.

Put your testing and measuring problems up to our engineering department

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King Knight Company, Underwood Bldg., San Francisco, Cal.

DIAMOND EXPANSION BOLT Co

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MANUFACTURERS

Expansion Bolts — Drills
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Blake Insulated Staples

Unequalled for telephone and bell wiring. The fiber insulation prevents troublesome short circuits and grounds. 4 sizes. Pat. Nov., 1900. Write for samples.

Blake Signal & Mfg. Co.

BOSTON, MASS.

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Soldering Salts

Buy it of your jobber in ½-lb., 1-lb. and 5-lb. blue and white enameled cans and 50-lb. cans. New prices for 1922.

Alex R. Benson Co., Inc., Hudson, N. Y.

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RUBBER COVERED
TELEPHONE WIRES

for every conceivable use. Braided, Leaded and Iron Armored Telephone Cables, Conductors straightway or paired

Manufactured by

Indiana Rubber and Insulated Wire Co.

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Automatic Water Stills

Absolutely pure water for less than one or two cents a gallon, no matter how polluted your supply of water may be. For drinking, chemical, or battery purposes the Peerless stills give you the best, ample supply at lowest cost.
Operated without attention other than occasional cleaning.
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Write for complete details.

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STANDARD

THIS name applied to telephone wires and cables means what "Sterling" does when applied to silver—a guarantee of quality recognized by all discriminating buyers.

Standard Underground Cable Company

Pittsburgh, Pa.

PROTECTIVE DEVICES (Q—2—2)

LIGHTNING ARRESTERS

AURORA BOREALIS. The appearance of the aurora borealis or "Northern Lights" is accompanied by severe magnetic and electric disturbances which ordinarily cause much trouble in telephone and telegraph lines. The wavering streamers and colored curtains of the aurora are located at very high altitudes in semi-vacuous space, and are thought to be due to a bombardment of the electrons discharged from the sun during the sun spot periods. They are apparently connected with the solar disturbances and also with magnetic storms since all three manifestations occur simultaneously in cycles of about 11.5 years. While the electrostatic charges during an aurora are very intense at high altitudes, they do not seem to statically charge the lower atmosphere to any extent, the troubles near the earth's surface being rather of an electromagnetic nature than static.

At high altitudes in mountainous country, the air static is very strong, and passes off of a metal conductor in a continuous stream. Within or close to the arctic circle, particular attention must be paid to providing an easy discharge path for this static so that it may ground continuously without raising the potential of the line to any extent. This is particularly true with lines run through mountainous country.

PROTECTION AGAINST NATURAL ELECTRICAL CHARGES. To protect telephone apparatus against damage, and to prevent interruptions to the service, protective devices must be placed within the circuit which will ground all foreign charges, but which will not disturb the line of current. They must afford so easy a path that the potential due to static rises as little as possible. Up to date this has only been partially accomplished and the appliances are very subject to disorders which in turn call for readjustment after severe storms. Most all of these devices are based on the gap idea, that is, a grounded plate is separated by a short distance from the edges of a plate connected with the line, the high tension high frequency static being supposed to jump this gap while the low tension line current remains well insulated from the ground. Except for the discharge of atmospheric static and mild inductive charges due to nearby lightning strokes, such arresters are practically valueless. They cannot hope to cope with a direct lightning stroke nor even with the induced charge caused by a stroke a few feet away from the line.

In general, the present lightning (or rather static) arresters may be divided into three principal classes:

(1) AIR GAP ARRESTERS in which the static jumps to ground across a thin air gap placed between two metal or carbon plates. As such gaps offer high resistance, they maintain a high static potential and never rid the line of static. They are extensively used however, principally because of their simplicity and low cost.

(2) VACUUM GAP ARRESTERS. It is well known that a current will jump a given gap at lower voltages if the gap is in a partial vacuum. This principle is utilized in the vacuum type arrester in which the gap between two electrodes is placed within an evacuated glass tube. The discharge voltage is less with this arrester than with the air gap type and a lower potential is maintained. Less damage is commonly worked with heavy discharges, and they need little attention.

(3) HIGH RESISTANCE ARRESTERS. A type in which some granular or flaky conducting material is mixed up with a pulverized non-conductor such as clay. The conducting material is scattered sparsely through the insulator, and while the static readily jumps from particle to particle on its way to the ground, the high resistance effectively prevents the grounding of the line current. It is inserted like a resistance block between the line and ground and has no definite single air gap. This, however, has certain objections and is not an ideal arrester, although it is desirable because of its simplicity.

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MATHEMATICAL TABLES (BB—16—12)

ANNUITIES OR SINKING FUNDS

GENERAL NOTES. If a given amount (A) is set aside at the end of each year, this with the accumulated interest, yearly interest (r) will amount to the total required sum (S) at the end of (N) years. Here, (r) is the interest rate per annum in per cent, compounded annually. Let (c) be a constant involving interest rate and time by which the annual amount (A) is determined by: $A = S \times c$. The value of (c) is determined by the following equation:

$$c = \frac{(r/100)}{([1+(r/100)]^N - 1)}$$

The following table greatly simplifies the calculation, various values of (c) being given in the body of the table for different periods of years (N) and various rates of interest (r).

TABLE OF ANNUITIES OR ANNUAL SINKING FUNDS

Years	Rate of Interest (r) Compounded Annually								
(N)	2%	2.5%	3%	3.5%	4%	4.5%	5%	6%	7%
2	.49505	.49383	.49261	.49140	.49020	.48900	.48780	.48544	.48309
3	.32675	.32514	.32353	.32193	.32035	.31877	.31721	.31411	.31105
4	.24262	.24082	.23903	.23725	.23549	.23374	.23201	.22859	.22523
5	.19216	.19025	.18835	.18648	.18463	.18279	.18097	.17740	.17389
6	.15853	.15655	.15460	.15267	.15076	.14888	.14702	.14336	.13980
7	.13451	.13250	.13051	.12854	.12661	.12470	.12282	.11914	.11555
8	.11651	.11447	.11246	.11048	.10853	.10661	.10472	.10104	.09747
9	.10252	.10046	.09843	.09645	.09449	.09257	.09069	.08702	.08349
10	.09133	.08926	.08723	.08524	.08329	.08138	.07950	.07587	.07238
11	.08218	.08011	.07808	.07609	.07415	.07225	.07039	.06679	.06336
12	.07456	.07249	.07046	.06848	.06655	.06467	.06283	.05928	.05590
13	.06812	.06605	.06403	.06206	.06014	.05828	.05646	.05296	.04965
14	.06260	.06054	.05853	.05657	.05467	.05282	.05102	.04758	.04434
15	.05783	.05577	.05377	.05183	.04994	.04811	.04634	.04296	.03979
16	.05365	.05160	.04961	.04768	.04582	.04402	.04227	.03895	.03586
17	.04997	.04793	.04595	.04404	.04220	.04042	.03870	.03544	.03243
18	.04670	.04467	.04271	.04082	.03899	.03724	.03555	.03236	.02941
19	.04378	.04176	.03981	.03794	.03614	.03441	.03275	.02962	.02675
20	.04116	.03915	.03722	.03536	.03358	.03188	.03024	.02718	.02439
25	.03122	.02928	.02743	.02567	.02401	.02244	.02095	.01823	.01581
30	.02465	.02278	.02102	.01937	.01783	.01639	.01505	.01265	.01059
40	01656	.01484	.01326	.01183	.01052	.00934	.00828	.00646	.00467
50	.01182	.01026	.00887	.00763	.00655	.00560	.00478	.00344	.00238

EXAMPLE. Find the annual payment (A) required as a sinking fund for a total amount (S) of $100,000 at the end of five years, interest rate (r) 5 per cent, compounded annually.

From table $c = .18097$, hence $A = S \times c = 100{,}000 \times .18097 = \$18{,}097.00$ annual payment.

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Engineers and Draftsmen

We have positions in our Central Office Engineering Division for men with college training in engineering or the physical sciences. Practical telephone experience may take the place of college training.

We can also place draftsmen who have had technical high school training and from two to four years' drafting experience, preferably in the power or telephone fields.

Our work requires men who are capable of development and who seek permanence.

In these positions you would be located at our Hawthorne Works in a suburb of Chicago.

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Employment Division

Western Electric Co.

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Hawthorne Station

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A handy rope-pull type

BARTLETT COMPOUND LEVER TREE TRIMMER

This special type developed for the Western Electric Co. has the easy cutting qualities of the famous Bartlett No. 1 tree trimmer.

It is insulated; operated by a rope-pull and a 14 inch pull lever which increases the cutting power; and is supplied with two additional four foot sections so it may be extended as long as 16 feet. Each tool guaranteed.

Bartlett Tree Trimmers are standard with leading telephone and telegraph companies.

Write for full particulars.

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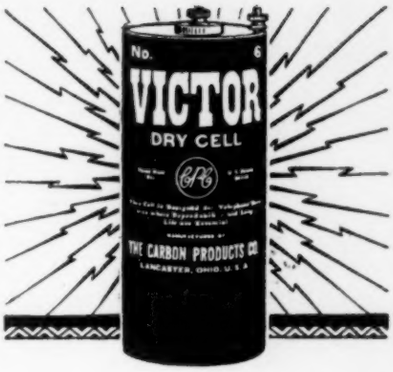

Has There Been Any Improvement in Dry Batteries in Recent Years?

This Open Letter Answers the Question

Telephone Engineers:

Gentlemen:

In response to the oft-asked question regarding the progress made in dry battery manufacture, it is certain that a higher grade battery is available now than was the case in former years. Perhaps no outstanding features have been noticeable in general, but there is definite proof of improvement in the Victor Dry Battery.

To produce a battery that has a higher voltage than you have been accustomed to, prognosticates that "there's something different in Victors." The fact that these telephone batteries recuperate much more than other cells, and outlast any that have been put on the same service test with them, proves that the "something different" must be something better.

We, therefore, invite your consideration of a telephone battery that is ahead of the times--or, at any rate, in pace with telephone equipment advancement. Yours truly,

THE CARBON PRODUCTS CO.

Victor Telephone Cells

Manufactured by

THE CARBON PRODUCTS CO.

Telephone, Ignition, Wireless and Flashlight Batteries and Carbon Products

LANCASTER, OHIO

ALTERNATING CURRENTS (EE—14—12)

HIGH FREQUENCY INDUCTANCE AND WAVE LENGTHS

WAVE LENGTH. An electromagnetic wave travels at the rate of 300,000,000 meters per second (approximately 186,000 miles per second). The frequency of the oscillations set up by the wave depends upon the inductance and capacity within the circuit, but in any case the wave length is equal to the velocity of the wave divided by the frequency. This, if w = wave length in meters, N = frequency of wave per second, and V = velocity of wave in meters per second, then,

$$w = V/N = 300{,}000{,}000/N \text{ or } wN = 300{,}000{,}000.$$

The wave length of the electromagnetic wave and the frequency of the related current in the circuit bear a fixed relation and this is of fundamental importance in such circuits as those used in radio telegraphy and telephony, since the static and magnetic line of the wave are reversed as many times as the oscillations in the circuit are reversed.

In a circuit having an inductance (L) and a capacity (C), the natural or fundamental wave length is expressed by the equation:

$$w = 6.2832V\sqrt{LC} \text{ and a frequency: } N = \frac{1}{6.2832\sqrt{LC}}$$

Approximately, a single vertical wire has a wave length equal to about four times its length, while a single horizontal wire tapped at one end will have a wave length of from four to five times the length of the wire. With two or more parallel wires, these simple rules no longer apply and the wave length must be determined by direct measurement. In the above equations, the expression $\sqrt{LC}$ is called the oscillation constant.

Let w = wave length in meters.
C = capacity in microfarads.
N = frequency of oscillations per second.
L = Inductance in centimeters (1000 = 1 microhenry).

Then these quantities bear the relations worked out in the table.

TABLE OF WAVE LENGTHS AND RELATED FACTORS

w	N	$\sqrt{LC}$	LC	w	N	$\sqrt{LC}$	LC
100	3,000,000	1.680	2.820	600	500,000	10.07	101.41
120	2,500,000	2.020	4.080	620	483,900	10.40	108.15
150	2,000,000	2.52	6.35	650	461,500	10.90	118.81
170	1,764,600	2.85	8.12	700	428,600	11.74	137.83
200	1,500,000	3.36	11.29	750	400,000	12.58	158.27
220	1,363,500	3.69	13.62	800	375,000	13.42	180.10
250	1,200,000	4.19	17.55	850	352,900	14.26	203.35
270	1,111,000	4.53	20.52	900	333,300	15.10	228.01
300	1,000,000	5.05	25.30	950	315,800	15.94	254.08
320	937,400	5.37	28.84	1000	300,000	16.78	281.57
340	882,300	5.70	32.49	1050	285,710	17.62	310.50
350	857,100	5.87	34.46	1100	272,730	18.45	340.40
360	833,300	6.04	36.48	1150	260,860	19.29	372.10
370	810,800	6.21	38.56	1200	250,000	20.13	405.20
380	789,400	6.38	40.71	1250	240,000	20.97	439.70
400	750,000	6.71	45.03	1300	230,760	21.81	475.70
420	714,300	7.05	49.70	1350	222,220	22.65	513.00
450	666,700	7.55	57.00	1400	214,380	23.49	551.80
470	638,300	7.89	62.25	1450	206,900	24.33	591.90
500	600,000	8.39	70.39	1500	200,000	25.17	633.50
520	576,900	8.72	76.04	1550	193,540	26.00	676.00
550	545,400	9.23	85.19	1600	187,500	26.84	720.40
570	526,300	9.56	91.39	1650	181,820	27.68	766.20
				1700	176,460	28.52	813.40
				1750	171,430	29.36	862.00

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COMPILED BY
J. B. RATHBUN

RADIO PRINCIPLES (Z—7—30)

DUO-LATERAL (HONEYCOMB) INDUCTANCE COILS

DIMENSIONS OF DUO-LATERAL COILS. The size of a duo-lateral inductance coil depends primarily upon its inductance (Millihenrys), but in commercial coils the rating is generally given in terms of the number of turns. There is necessarily some difference in the inductance among different makes of coils having equal numbers of turns, and occasionally among different coils of the same make, but this difference is not generally very great. The difference in distributed capacity is more pronounced, varying with the method of winding and the materials used in the insulation. The choice of any particular number of turns and inductance depends upon the wave lengths used and the desired relations existing between the primary aerial circuit, the secondary circuit and the tickler circuit. In the following table is given the properties of the well-known Giblin-Remler inductance coils, which have a very low distributed capacity due to the method of separating adjacent turns by an air space.

PROPERTIES OF GIBLIN-REMLER INDUCTANCE COILS

No. of Turns (Ratg.)	Induct. in Mil-Henrys 1000 Cycles Per Second	Natural Wave Lengths (Meters)	Distrib. Capacity Micro-Micro-farads	Wave Length Range in Meters with Condenser of 0.001 M. F. Capacity (Max.) Min.	Max.	High Frenquency Resistance in Ohms at Wave Length of 200	500	1000	2000
20	0.030	39	14.3	63	334	....	1.1	....	....
25	0.041	47	15.2	75	389	....	1.5	....	....
35	0.083	87	25.4	128	550	....	3.5	....	....
50	0.169	114	21.6	185	785	....	8.8	4.4	....
75	0.377	163	19.8	266	1170	....	28.3	12.1	6.2
100	0.666	217	19.9	358	1550	....	80.3	26.8	12.6
						Ohms at Frequency of 1000	2000	5000	10000
150	1.503	281	14.8	512	2320	69.8	23.8	7.1	....
200	2.680	374	14.7	690	3110	....	50.6	12.5	....
250	4.200	424	12.1	860	3880	....	87.5	19.9	....
300	6.110	494	11.2	1030	4680	....	141.0	29.3	13.8
400	11.040	618	9.7	1380	6300	....	....	54.6	22.3
500	17.500	747	9.0	1730	7900	....	....	93.1	34.9
						Ohms at Frequency of 2000	5000	10000	20000
600	29.200	1024	10.1	2260	10250	....	111	43.8	....
750	39.000	1249	11.3	2660	11850	....	....	64.0	....
1000	71.600	1620	10.3	3570	16000	....	....	123.0	....
1250	108.0	1930	9.7	4380	19700	....	....	....	....
1500	159.8	2300	9.3	5300	23800	....	....	....	....

WAVE LENGTH ARRANGEMENT. In the following table are shown the usual arrangement of duo-lateral coils in the three circuits of a receiving set having an aerial primary, secondary and tickler circuit. The primary and tickler coils are movable and mounted on either side of the stationary secondary coil.

DUO-LATERAL COILS IN REGENERATIVE RECEIVER

Wave Lengths in Meters	Primary Coil Turns	Secondary Coil Turns	Tickler Coil Turns
200- 450	50	25 to 50	75
400- 825	150	100	100
800- 1,850	200	150	100
1,500- 2,750	300	200	150
2,500- 4,200	200	300	150
4,000- 6,350	300	400	200
6,200-14,500	1,250	750	400
13,000-20,000	750	1,250	400

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